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AND
AMERICAN RAILWAY JOURNAL.

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COMPRESSED AIR FOR POWER is being employed by E. D. Smith & Co., who are driving a two-mile tunnel for the Metropolitan Water-Works, of Boston, Mass. The tunnel is 11½ × 13½ ft., with four shafts and a portal. No. 1 shaft is 40 ft. deep; No. 2 shaft, 118 ft.; No. 3 shaft, 111 ft.; No. 4 shaft, 58 ft. deep. The entire work (including drilling, pumping and hoisting,) is being done by compressed air. The air is furnished from a plant placed betwen the portal and shaft No. 4. Air is carried about half the distance through an 8-in. pipe, then reduced to 6 ins., and afterwards to 4 ins. The air is furnished by two duplex Corliss engine air compressors, with steam and air cylinders 20 × 36 ins., built by the Rand Drill Co., which also furnished 24 slugger drills for the work. The plant has been fitted with a view to doing rapid and economical work on the tunnel. E. D. Smith & Co. have also made good progress on the work at Niagara Falls, where they are sinking a wheel pit 280 ft. long, 185 ft. deep, 20 ft. wide, for the Niagara Falls Power Co., the drilling, channelling and pumping for which are done with compressed air furnished by a Rand duplex Corliss engine air compressor, with cylinders 20 × 30 ins.

ELECTRIC TRACTION is to supersede cable traction on the Wylie Ave. line of the Consolidated Traction Co. at Pittsburg, Pa. The cable was stopped at midnight on Aug. 26, and then withdrawn from the conduit. The engines and driving plant will be taken out. The conduit and track construction will be torn up, new tracks laid and the street repaved. All this work will be done by Booth & Flynn, the contractors.

THE AMMONIA MOTOR CAR of the Standard Fireless Engine Co. was given a trial recently on the tracks of the East Louisiana Ry. Co., at New Orleans, La. The company desires to have its motor put in service on one of the street railways of the city.

THE STREET RAILWAYS OF THE UNITED STATES, says the last edition of Poor's "Manuel," aggregate 15,956 miles in length, as compared with 13,176 miles last year; in five years the gain in mileage has been 6,294 miles. These lines possess an equipment, so far as the unsatisfactory statistical returns will show, of 28,154 passenger cars, 20,777 motor cars, 206 dummies and 28,621 horses. Since 1891 the number of horses in street railway service has declined 162,000, or about 80%. Out of the above mileage lines aggregating 531 miles failed to make complete returns of capitalization, etc. The 15,425.42 miles reporting show a capitalization of $828,547,285 in stock, and $525,949,928 in bonds; an average of $87,809 per mile in stock and bonds as compared with an average of $60,188 per mile for steam railways.

A GASOLINE STREET CAR has been built at the shops of the Anacostia Ry. Co., Anacostia, D. C., being fitted with a motor invented by Mr. T. C. Pole, of Washington, D. C. The car has two sets of gearing, one for a speed of six miles and the other for twelve miles per hour. The gas engine is of 25 HP. and drives two heavy flywheels, the engine and flywheels running constantly at a uniform speed independent of the speed of the car. The car weighs about six tons and seats 25 persons.

THE CHIGNECTO SHIP RAILWAY ENTERPRISE is being revived in an attempt to have the Dominion subsidy renewed as a preliminary to raising more funds. This subsidy amounts to $170,602 annually for 20 years; but as the terms imposed upon the company were not complied with, it has been withdrawn by the Dominion Parliament. About $3,000,000 has already been expended upon the ship railway.

THE FIRST RAILWAY IN COREA to connect the port of Chemulpo with the capital town of Seoul, 25 miles distant, is to be built by an American, Mr. James R. Morse. Mr. Morse was one of the first foreigners to enter Corea when it was opened to foreign trade in 1882 and holds other concessions, for mining, electric lighting, etc. The route of the railway has been surveyed by Mr. J. H. Dye, also an American, and the estimated cost of the road is $1,500,000 in gold. Seoul is only 100 ft. above sea level and the chief engineering work upon the line is a bridge, 1,600 ft. long, across the Han River. Under the terms of the concession the work must be commenced before March 29, 1897, and it must be finished within two years thereafter. The concession is for 15 years after opening, and it can then be purchased by the Corean government, or the concession extended for further periods of ten years. A French company has obtained a similar concession for a railway from Seoul north to Wi Ju, on the Chinese frontier.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was caused by the collapse of a wooden bridge span in a trestle carrying the Arcata & Mad River R. R., over Mad River, near Eureka, Cal., Sept. 13. The train was running at very slow speed, as was the custom in crossing the trestle. It was an accommodation train, consisting of an engine, box car and two day cars, all of which went down. Of 20 persons on the train, 4 were killed and 12 injured, some being fatally injured. It is said that the bridge had one pier in the river.

AN OIL TANK CAR exploded at Wellington, Ill., Sept. 10, setting fire to adjacent cars; 25 cars and a grain elevator were burned.

A POWDER EXPLOSION occurred Sept. 11 at the mills of the Ohio Powder Co., near Youngstown, O., causing the death of two men.

THE SHAFT OF THE STEAMER "City of Worcester" broke Sept. 10 while the vessel was on its way down Long Island Sound, from New London to New York, and the steamer had to be towed into port.

A SMALL WATER TANK BURST at Washington Heights, one of the sections annexed to Chicago a few years ago. The tank formed a part of the water system owned by the former town of Washington Heights. It had a capacity of 60,000 gallons, was elevated, and apparently was of wood, as press reports state that "several iron bands burst."

A SURVEY OF TWO RESERVOIR SITES, one in Wyoming and the other in Colorado, was provided for by the last Congress. The examination of these sites has been placed in charge of Capt. Hiram Chittenden, U. S. Engineer, St. Louis, Mo. Capt. Chittenden was to confer on this subject, on Sept. 10, with Mr. Elwood Mead, M. Am. Soc. C. E., State Engineer of Wyoming. The purpose of the proposed reservoirs would be to store flood waters and thus relieve the lower Mississippi from the danger of floods in times of high water and improve its navigation at low water.

A SUIT TO RECOVER DAMAGES for death alleged to have been caused by decomposing garbage has been instituted against the city of New Albany, Ind., by the widow of the deceased. Damages to the amount of $20,000 are claimed for the death of the man and the subsequent illness of the plaintiff and her three children. A few days before the filing of this suit another one was filed by a different person to recover $5,000 damages for depreciation of property. The garbage in question is reported to have been dumped on a vacant lot.

THE BARKER DRIVE-WELL SYSTEM, recently patented by Delbert L. Barker, says the Providence "Journal," is intended to develop water from pipe-wells driven into fine sand. The plan includes the sinking of an open pipe, larger at the bottom and armed with teeth, by using a jet of water under pressure. When a water-bearing sand-stratum is reached, the sinking is stopped, but the hydraulic washing goes on until a cavity is formed at the foot of the pipe. Into this cavity gravel or other coarse filtering material is introduced; and as the jet action can be continued to enlarge the opening by washing the fine sand up the pipe, an artificial filter-bed of considerable size can gradually be formed. It is claimed that more water can thus be obtained than by the ordinary driven well.

A BASCULE BRIDGE has been decided upon by the Board of Aldermen of Brooklyn and the Queens County Board of Supervisors as the type of structure to span Newtown Creek, at Vernon Ave., Brooklyn, N. Y. Various plans for bascule, lift and swing bridges had been submitted in answer to the advertisements in the columns of Engineering News, but no particular plan was adopted.

THE EXTENSIVE FREIGHT TERMINALS of the Illinois Central R. R. at New Orleans, La., are nearly completed. The terminals occupy a space of 14 blocks at the head of Louisiana Ave., and are built largely on ground made by filling in. The plant includes a wharf 1,000 ft. long and 100 ft. wide, six miles of tracks, cotton storage sheds of 100,000 bales capacity, freight sheds, and a grain elevator of 1,000,000 bushels capacity. The elevator is 83½ × 300 ft., and 165 ft. high, supported on 3,000 piles 45 ft. long, carrying brick piers on which rests the main framing of the building. It has two parallel tracks with steam unloaders, handling 250 to 300 cars per day, one track having seven and the other four unloading legs, from which the grain is delivered to the 180 bins. Mr. L. L. Dagron is the Resident Engineer for the railway company, and James Stewart & Co. are the contractors for the elevator.

A RUSSIAN-AMERICAN MINING AND METALLURgical Company, says the Philadelphia "Record," has been organized in Russia by Mr. Edmund D. Smith, vice-president of the Russian-American Manufacturing Company. This new company is to be conducted largely with American capital and entirely under American management. It is called the Nicopal-Mariopal Mining and Metallurgical Company, with a paid-up capital of $2,275,000, gold, and proposes to secure control of valuable manganese mines at Nicopal, in South Russia. These mines are now under American management, and the ore is to be taken to Mariopal, on the Sea of Azov, where a large steel plant will be erected under the charge of H. S. Loud, formerly of the Illinois Steel Company. The company has already secured the contract for suppiying 144 miles of oil-pipe, amounting to about 10,000 tons, in the Caucasus; and to make the delivery in time the company has purchased the entire pipe-plant of Morris, Tasker & Co., with the exception of engines and boilers. This plant is now being shipped to Russia and the pipe is all to be delivered next year. The Russian-American locomotive works, at Nijni Novgorod, is to be opened as a department of the Sormovo Iron & Steel Works, at that place. The plant to be used has been designed by Walter F. Dixon, of Paterson, N. J., and Julian Kennedy, of Pittsburgh, Pa.

TRADE WITH COSTA RICA is to be fostered by the establishment of a consulate in Philadelphia, and Mr. Gustavo Niederlein, Consul for Costa Rica, 233 South Fourth St., Philadelphia, Pa., notifies us that he will be glad to receive two sets of catalogues from manufacturers, together with particulars of terms of credit and discount, freight, etc. He will also be pleased to answer inquiries as to the character of goods desired, etc. Some notes on the Costa Rica Ry. will be found in our issue of July 9.

A TWIN-SCREW ELECTRIC LAUNCH has been built at Nyack for John Jacob Astor. The boat is built of mahogany, and is 70 ft. long by 8½ ft. beam, and is 4 ft. draft. Two electric motors of 25 HP. each are fed by a battery of 480 cells. She was designed by Mr. Mosher.

THE PIG-IRON INDUSTRY, says the "Iron Age," is adjusting itself to the late change in conditions, and since May 1 there has been a decline in production from 189,400 tons per week to 130,500 tons on Sept. 1. On Jan. 1, 1896, 241 furnaces were making 207,481 gross tons per week; and on Nov. 1, 1895, the maximum was reached with 217,306 tons per week. On Sept. 1, 1896, only 145 furnaces were in blast.

THE TRANSMUTATION OF SILVER INTO GOLD by a chemical or metallurgical process is claimed to have been accomplished by Dr. Stephen H. Emmens, the inventor of the explosive, "Emmensite." The "Engineering and Mining Journal" of Sept. 5 contains a letter from Dr. Emmens, in which he reiterates his claim, but gives no details as to his methods. The "Journal" thereupon says, editorially: "So far as our knowledge goes there is nothing yet known that gives any firm ground for a belief in the transmutation of the elements; in fact, the tendency of scientific investigation seems to lead to the opposite conclusion. Neither is there anything in Dr. Emmens's statements that would convince any careful investigator that he has succeeded in converting silver into gold."

THE NATIONAL ASSOCIATION OF STATIONARY Engineers is meeting in Cleveland, O., this week, with over 400 members in attendance. The association has over 10,000 members. Its objects are the scientific education of engineers and promoting the enactment of engineers' license laws in order to prevent destruction of life and property in the generation and transmission of steam. It has nothing to do with the subjects of wages, strikes, etc.

HINGED CONCRETE BRIDGE ACROSS THE DANUBE.*

(With inset.)

This bridge, which was designed and built under the supervision of Mr. Max Leibbrand, engineer, connects the village of Inzigkofen with its railway station on the opposite side of the Danube River. The traffic being very small, the appropriation had been put at the lowest possible limit, and it was necessary to observe the greatest economy in deciding upon the kind of structure and the materials to be used and in designing the structure. The condition of the river and river bed was not suitable for the use of intermediate piers, but the presence of solid rock on the right bank of the river and a hard gravel on the left favored the adoption of an arch.

As there were no stone quarries in the vicinity, while a factory producing most excellent cement was located within a short distance, it was decided to build the arch of concrete. Comparative estimates showed this to be a cheaper construction than either a Monier arch, or one of iron alone, or of cement blocks. An important feature of the design is the placing of open cast-iron links or joints at the crown and at the abutments. The arch hinged in this manner is statically determinate, and may be rationally and economically computed; moreover, any danger through settlement, after the falsework has been removed, is eliminated, as are also any secondary strains due to changes in temperature or to variations in the vertical loading, to which the arch can freely accommodate itself.

VIEW OF HINGED CONCRETE ARCH OVER THE DANUBE RIVER NEAR INZIGKOFEN, GERMANY.

The following dimensions were adopted: Span, 43 meters (about 141 ft.) and a rise of 4.38 meters (about 14 ft. 4 ins.). There is one roadway, 2.5 meters (8 ft. 3 ins.) wide, and two sidewalks, each 0.65 meters (2 ft. 1½ ins.), aggregating 3.8 meters (12 ft. 6 ins.) as the width between railings. The width of the arch proper is 3.6 meters (11 ft. 9½ ins.) at the crown and increases to 4.6 meters (15 ft. 1 in.) at the abutments, thus affording an increased resistance to all lateral pressures, such as wind, high water and ice. The arch ring is 0.7 m. at the crown, 1.1 m. at the joint of rupture, and 0.78 m. at the abutments. The roadway is carried on 36 small posts standing upon the extrados of the arch, except in the middle portion where it is carried directly on the arch. As shown in the section each three of these pillars forms a bent, the two outer ones being curved at the bottom on account of the greater width of the arch ring; longitudinally the pillars are joined by arches. On top of the abutment are rollers to provide for expansion and contraction of the roadway structure. At the crown joint the wrought-iron handrail is connected to a cast-iron post in which it is free to move, and at this point the roadway is supported on trough plates.

Without entering into the details of calculation, it is of interest to note that the usual method of establishing the line of pressure by loading one-half of the arch ring was not followed in this case, but the arch was divided into sections, and the effect of concentrated loads at these sections was determined. Indeed, the hinged construction demands this method of calculation, as the problem is a determinate one, and the arch cannot be regarded as one elastic mass.

Construction was started in July, 1895, with blasting and excavation for the abutments, and the bridge was opened to traffic in November of the same year. All concrete used was mixed by hand, and the various proportions adopted for different parts of the bridge are indicated in the illustrations on our inset sheet. The bents of the lightly constructed falsework were carried on four piles each; resting on the cap-pieces of these piles were sand boxes and wedges, as shown. The planking under the arch projected sufficiently beyond the face to allow the sideboarding to be braced against it. The abutment links were supported on saddles bolted to the arch ring of the falsework. These saddles served the purpose of resisting the thrust of the arch before it had been closed and filled in at the abutments. The abutment plates were each provided with four lugs and bolts in order to hold them in position during the concreting. Before the falsework was removed the lugs were knocked off and the bolts drawn out, leaving the hinge free to turn on its axis. The crown hinge was supported on timbers directly over the arch planking.

It is of the greatest importance that the axis of each set of links should be in true alinement, and perpendicular to the arch, as otherwise it would not be possible for the links to turn simultaneously, and secondary strains would arise, rendering the hinge construction useless. Behind the abutment links a space of 25 cm. (about 10 ins.) was left open to admit of the hinge following the settlement of the falsework; this space was not filled in until the arch was closed. The joints in the planking on the face of the arch were caulked with gypsum, and the interior surface covered with brown paper. The model of the arch ring, formed in gypsum, was then screwed on, and the whole coated with shellac. The planking below the arching was left rough, except for a space of 20 cm. next to the face, this strip being treated similarly to the front. Before concreting was commenced the falsework was loaded at the crown with the links and a number of sandbags, aggregating 40,000 kg. (about 88,200 lbs.). On Aug. 29 the concreting of the arch was started at the abutment links. The material was placed in sections boarded off perpendicular to the line of pressure, and from 1 to 1.3 m. long, and tamped in horizontal layers. The arch thus consists in reality of a number of concrete blocks of that length which, however, through the speedy progress of the work were most completely united. The concreting was advanced from both sides towards the joint of rupture; here a space of 1.2 m. was left open and work continued beyond this space towards the crown, the loading placed on the falsework being gradually removed. The open spaces at the abutments, and at the crown, were then closed, and finally those at the joints of rupture while concreting the spaces at the abutments. The end plates were supported on set screws, the strength of which was sufficient to withstand the slight thrust of the uncompleted arch, but not that of the arch when unsupported by the falsework. In this manner it was insured that the joints distributed the pressure over the whole surface, and not merely at the points of support.

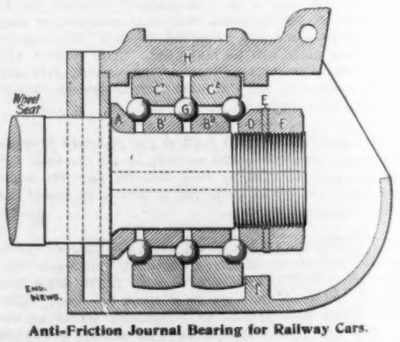
The abutment piers were built next, and finally the pillars and arches supporting the roadway. On all visible parts of the bridge a layer of colored cement and sand from 10 to 15 cm. thick was put in simultaneously with the concrete and closely united to it.

Immediately after the roadway was completed and five weeks after closing the arch the falsework was removed. The settlements at the crown and at the abutments were closely observed from time to time by means of the apparatus shown in the illustration. The total settlement at the crown amounted to 32 mm., about 1¼ in., estimated at a temperature of 20°C. This was up to Feb. 10, 1896, the bridge in the meantime having been subjected to a test load. The roadway plates were covered with asphalted felt, ¼-in. thick, upon which was a layer of sand 4 ins. thick, then gravel, 3 ins. thick, which was finally covered with a thin layer of sand. The roadway is drained in the center and the water carried down the first row of pillars from the abutment. The total amount of concrete in the bridge is 634 cu. m., or about 830 cu. yds. The amount of cast iron in the hinges is about 33,000 lbs., and the whole work was executed at the estimated amount of 22,310 M., about $5,310.

*Abstracted from "Zeitschrift fuer Bauwesen," by O. J. Marstrand.

ANTI-FRICTION JOURNAL BEARING FOR RAILWAY CARS.

Among the various mechanical improvements in the design of railway rolling stock which the ever present inventor is suggesting for use, "improved" journal bearings are perhaps as seldom seen as any. Nevertheless, such devices are occasionally brought to our notice, and in the accompanying cut one of the latest ideas in this direction is illustrated. This bearing, according to the inventor's statement, is to be given a trial by a prominent western railway, and is also of interest as exemplifying the persistent attempt to extend the ball bearing to new uses, with which engineers have become familiar during the past two years. It may be noted that the trail of the bicycle can be seen in the design, the inventor having been engaged in the manufacture of wheels and having developed his journal from suggestions obtained in that work.



Anti-Friction Journal Bearing for Railway Cars.

The device illustrated consists of a hardened steel collar A keyed securely to axle; collars B^1 and B^2 movable longitudinally on axle, but made to rotate with axle by means of a feather or key, and collars C^1 and C^2, which are confined loosely within the oil box and separated from B^1 and B^2 by a series of rows of balls. The collar D is screwed on to the axle, and forms one of the bearing surfaces, and is the adjusting nut by which all looseness or play may be taken up. This collar is locked in position by means of a washer E, containing a feather, which prevents it from turning on the axle, and F a lock nut. A cotter will be

used to prevent this nut from coming clear off the axle in case it should accidentally work loose. The oil box is made in two pieces, which are held in position by the jaws of the pedestal, and may be readily removed by jacking up the car body ½-in. The box is tight, and, it is stated, wastes no oil, as there is barely enough used to allow the balls to pass through it at the lowest point in their revolution around the axle. Hardened steel balls of 1 in. diameter are used. The collars are also made of a high carbon steel, carefully tempered, and their bearing surfaces are turned at an angle of 45 to the axis of the axle. This is done to eliminate all sliding friction between balls and collars, as it brings the axis of the balls parallel to that of the axle around which they rotate. The inventor, Mr. W. M. Shumway, of Chicago, Ill., states that the cost of this bearing is but little more than that of the ordinary journal bearing.

NOTES OF A TRANSCONTINENTAL TRIP.

(Editorial Correspondence.)

II.

Union Pacific Ry.

This line deserves celebrity for its position as one of the two great railways chartered by Congress to extend the railway system of the country to the Pacific coast, the other line being the Central Pacific Ry. In 1862 the U. S. government passed an act granting to these railways subsidies of bonds and lands to aid in the construction of a railway and telegraph line from the Missouri River to the Pacific Ocean, and it is much to be regretted that in both cases the debt thus incurred has resulted in clouding the history of the railways by financial embarrassments and by continual contests between the companies and the government. The Union Pacific Ry. was given 12,800 acres of public land per mile of road, and a subsidy in government bonds at the rate of $16,000, $32,000 and $48,000 per mile, the total amount being $27,226, 512 for 1,033 miles. The time fixed for the completion of the road was July 1, 1876, but as a result of the vigorous prosecution of the work the line was opened on May 10, 1869, simultaneously with the completion of the Central Pacific Ry. The original main line extends from Omaha, Neb., through Cheyenne, Wyo., to Ogden, Utah, 1,034 miles, but numerous branches, feeders and additional lines were built until the entire system aggregated a very considerable mileage. Of late years, however, owing to the financial troubles, many of these lines have been turned over to other companies, the latest line thus lost being that of the Oregon Railway & Navigation Co., the main line of which forms a northwest connection from the Union Pacific Ry. to Portland, Ore. This has lately been put under the control of a reorganized company. In 1893 the system operated had an aggregate length of 8,564 miles (including 982 miles of water lines), while the present operated mileage is 4,442 miles. West of Ogden may be seen the partly completed grade of the line built by the Union Pacific Ry. before Ogden had been decided upon as the junction point with the Central Pacific Ry., and when each company was straining every nerve to build as much mileage as possible in order to increase its subsidy.

The line has a good track, its standard rail being a 70-lb. rail which closely resembles the Am. Soc. C. E. section of that weight, but having top corners of ⅜-in. instead of 5-16-in. radius. The rails are laid with square, suspended joints, spliced with 40-in. bars and six bolts, but Mr. Geo. H. Pegram, M. Am. Soc. C. E., the Chief Engineer, is not in favor of such long bars. Burnetised ties of mountain pine and hemlock were at one time extensively used, the company having a plant of its own at Laramie, Wyo. The treated ties, however, lasted only about two or three years longer than untreated ties (8 years for the former as against 6 years for the latter), while they cost 14 cts. more, in addition to which there was the cost of transporting the ties to the treating plant and then back to the distributing point. It has, therefore, been concluded that it is cheaper and more economical to use untreated ties, but protected by metal tie-plates, and these plates (of the Servis and Goldie type) are now very extensively used.

A new spring rail frog has been designed by Mr. Pegram for use on this road, the special object in view in the design being to provide ample strength and security without unduly increasing the weight, as an increase in weight not only increases the cost but is also very likely to interfere with the easy working of the movable parts. The frog possesses many good features and costs from $3 to $12 less than those submitted by manufacturers. This frog will be illustrated in a later issue. Rigid frogs have but a short life on this road, averaging only one year, while in some cases they are cut out in two months by the pounding of heavy freight trains, and the pounding of the wheels of heavy cars in express trains of 12 to 16 cars, running at 60 miles an hour. These trains are hauled by powerful engines of the eight-wheel and ten-wheel types, and a notable feature of the locomotive equipment on this road is the use of the diamond stack and short smokebox instead of the cylindrical stack and extension smokebox which have been almost universally adopted within the past few years. This is referred to more fully below, and further detailed particulars will be published separately in a later issue. A number of bridges have been recently renewed with heavier structures, and in many cases the work of erection has been carried out with exceptional rapidity. The company is now rebuilding the bridges across the Weiser River, 400 ft. long, and across the Payette River, 270 ft. long, and a bridge of 172 ft. span across the Bear River on the Oregon Short Line. These are new steel bridges on stone piers taking the place of old wooden bridges on pile piers.

In regard to the express trains on this railway, above mentioned, it may be noted that our foreign friends, while admitting that good track and high speeds do exist on some of our main eastern lines, are very apt to assume that our western railways have tracks largely composed of mere streaks of rust and that the speeds are about equal to those of a wagon train or a prairie schooner. It would probably surprise them very considerably to find trains on the Union Pacific Ry. (as on many other main western roads) with 12 to 16 cars, many of these being heavy sleeping cars, running easily and steadily hour after hour over an excellent track at a speed of 50 to 60 miles per hour. Yet this is a daily regular experience.

Locomotive Smokestacks and Smokeboxes.

On the railways of the eastern states the straight smokestack and extension smokebox are now almost universally adopted, and the diamond smokestack and short smokebox are practically obsolete and looked upon as representative of an antiquated practice, while the old balloon stack for wood-burning engines is almost forgotten, although both these latter forms of stack are in use to some extent on old engines and branch lines. It is therefore somewhat surprising to find on reaching the Union Pacific Ry. that the diamond stack and the short smokebox are the standard types and are found preferable to the straight stack and extension smokebox. The reason for this is partly in the character of the coal used and partly in the arrangement of the exhaust nozzles. The fuel is a light friable lignite, very apt to throw sparks, to check which a deflector and netting in the enlarged top of the stack is found much more effective than a netting in the smokebox, while the low nozzle used with the former gives better results than the high nozzle used with the latter. The form of smokestack has a wide and somewhat shallow top very different from the ordinary deep, enlarged top of the old diamond stacks. Lest it may be supposed that the Union Pacific Ry. uses old and antiquated engines with the old style of front end construction, it may be said here, that the road has a very fine equipment of modern engines, which have a fine appearance and do splendid work, as will appear from some further details which will be published separately from these notes. It might, perhaps, be thought that this particular detail of practice is due to local ideas and prejudices, rather than to actual conditions, but both forms of stacks and smokeboxes have been tried, with results as above noted. A few weeks later I found exactly the same conditions existing on the Western Division of the Canadian Pacific Ry., and sought an explanation from Mr. Cross, the Master Mechanic of this division, who is located at the Winnipeg shops. It seems that this road obtains lignite from Lethbridge, a semi-anthracite (really a bituminous) coal from Canmore, and anthracite from Anthracite, all these places being in the province of Alberta, on the eastern slope of the Rocky Mountains. The bituminous coal is used west of Canmore, and on the Western and Pacific divisions, and there the engines have straight stacks and extension smokeboxes.

The lignite is used east of Canmore, from Gleichen to Winnipeg. Most of the engines burning the Lethbridge coal, or lignite, have diamond stacks, though it is also burned on some engines having straight stacks. The engines with diamond stacks have stacks of the old style, with a deep enlarged top. These engines with diamond stacks have a low exhaust nozzle, set below the tubes, and any sparks are driven against the deflector cone in the stack (not against the netting) again and again and are churned up with the steam, until dead, while any live sparks which may finally escape through the netting are nearly dead and are not blown far away, so that even in dry weather there is little danger of their setting fire to grass, etc., beyond the plowed fireguard along the right of way. With a straight stack and netting in the smokebox extension a high nozzle is required, and being above the tubes and netting it creates a suction tending to draw the sparks through the netting, and any sparks which do get through are then blown high out of the stack like rockets. Reference has been made above to the balloon stacks of wood-burning engines, and the sight of a heavy express train on the Southern Pacific Ry. drawn by two powerful ten-wheel engines having huge balloon stacks and tenders piled high with wood, is particularly striking to eyes accustomed mainly to the engines of eastern railways. In another issue I expect to give further particulars, with illustrations, of western practice in regard to smokestacks and smokeboxes.

Omaha to Denver.

After a few hours spent in and around Omaha, I continued my journey westward, leaving at 3.30 p. m. (July 3), on the Pacific Express, which leaves Chicago (Chicago & Northwestern Ry.) at 10:30 p. m., for San Francisco, by way of Omaha, Neb.; Denver, Colo., and Ogden, Utah. This was a very heavy train, but hauled by one eight-wheel engine. In crossing Nebraska one notices the rich-looking country and the great number of trees planted in groups and rows on the roads and farms, these trees (mainly poplars) being evidently intended as wind breaks and snow protections. At Julesburg the train leaves the main line of the Union Pacific Ry. and turns south over the Union Pacific, Denver & Gulf Ry. to Denver, which city was reached at 8:10 a. m., July 4.

On this latter line, in the vicinity of La Salle, are shifting sands, extending for great distances, the sand gradually covering and killing all vegetation and trees. It also encroaches on the railway, and portable fences, like snow fences, are used to protect the line, especially in cuts, but these seem to be of only very temporary use, being soon surrounded and buried. The sand must be worse than snow, for it is continually giving trouble, while snow only occurs during a few months of the year. A mixture of snowdrift and sand-drift in a railway cut would be a very awkward thing to handle.

Mr. T. F. Dunaway, General Superintendent of the Union Pacific, Denver & Gulf Ry., states that they are troubled with sand drifting for a distance of about eleven miles, between mile posts 119 and 130, on the Julesburg line. This sand comes from a formation lying to the north of the line. High north winds blow the grass from exposed parts and drift the sand towards the track. It being a cattle range, the tramping of cattle to and from the river, for water, prevents vegetation from growing and keeps the sand stirred up so as to be easily moved by the wind. To prevent its covering the track, it is treated much in the same way as snow, by building snow fences to catch the sand. It is necessary to change the fences (which are 6 ft. high) once a year.

All along this part of the route, and from here

on at intervals all the way to San Francisco and up to Portland, one sees the jack rabbits and the prairie dogs or gophers in abundance, and they furnish endless amusement, besides recalling to mind the pictures in the old railway guides. The gophers are pretty little furry animals, not unlike yellow squirrels, and in some places the entire landscape is dotted with the mounds of sand which mark the mouths of their burrows. They usually scurry away when the train approaches, but occasionally one will sit up on the far edge of the ditch or on one of the mounds, and watch the train attentively or chatter excitedly at it. These little fellows are amusing enough, but the jack rabbits are still more so, and it must be a particularly sour or grim passenger who is not moved to exhausting laughter by their performances. The rabbits are not unlike large hares, sandy-brown and white in color, but with abnormally large and sensitive ears (hence the name jackass or "jack" rabbit). One of these fellows will sit immovable near the fence while the train approaches, and just as it is opposite him he will throw up his ears in alarm, and go off through the sage brush like the wind, with a nervous hopping and leaping action that will send a car load of sedate passengers into hysterical and breathless laughter. One begins almost to believe in Mark Twain's statement about a jack rabbit he saw from a train and which ran so fast that "long after he was out of sight we could hear him whiz."

Denver, Colo.

The general appearance of this city is very attractive, as it has fine buildings, wide streets which are well paved and well cleaned, and an abundance of parks and trees, all of which show to advantage in the bright clear atmosphere. It is situated at an elevation of 5,195 ft. above the sea level and has a population of about 150,000. The city has a remarkably clean and neat appearance, and there is a general air of substantialness and prosperity, although at the present time business is universally said to be dull. The best stores certainly excel those of New York in their general appearance and style, and in the artistic display of goods. The residence district has numerous large and handsome houses, and a specially noticeable feature is the beautiful condition of the lawns, due to an almost continual use of lawn sprinklers and a frequent use of lawn mowers. Among the handsome public buildings are the city hall, the Arapahoe County court house and the new capitol. The latter stands on the summit of a hill and is a very fine structure, built entirely of Colorado products and manufactures. It is not yet quite completed. Some of the public school buildings are quite imposing structures, and in one of them is the city free library. The union station is a handsome stone building, at the side of the tracks, but has no train shed and no covered platforms between the tracks. In fact, this condition is found so frequently at new station buildings (as at Denver, Pueblo and Ogden) that one is led to wonder whether the architects purposely omit these shelters for fear of spoiling the view of the buildings. This station was completed in 1894.

There is a very complete system of street railways, extending far out into the suburban districts, and most of the lines are operated by electricity, some of which have replaced cable lines, the conduit system remaining undisturbed. Combination cars, partly open and partly closed, are extensively used on the cable lines, and the grip cars of these lines have track brakes.

In walking through the residence streets one wonders at the beehive-shaped structure of brick plastered with cement which stands near the front fence of every front yard or garden. Ideas of a new system of individual garbage cremation begin to occur, until on inquiry it is learned that these are the receptacles for ashes, the ashes being thrown in at the open top and periodically shoveled out by an ash collector through what looks like a furnace door at the bottom. The position of Garbage Commissioner is held by a woman, Mrs. Mary Pickerell, who is said to be a very smart woman and a very alert garbage commissioner. Denver has other public offices held by women, including that of City Treasurer, and, as far as could be learned, the results of this have been highly satisfactory, the women being good managers, well informed as to their duties and are not apt to dabble in municipal "rings" or to go into politics to the neglect of their municipal duties. Women and bicycles go together a good deal in these days, and so it may be appropriate to note here the very extended use of the bicycle by women and men in this city. They ride to and from business; they go shopping and calling, and they go from place to place about the city in ordinary daily pursuits, where in New York they would either walk or take a car. This very general use of the bicycle is due largely to the finely paved streets, many of which have asphalt paving.

The organization of the municipal engineering department is somewhat peculiar. There is a city engineer, but he is in charge only of grades and street line surveys. There is, however, more work in this than might be supposed, as the city covers a considerable area, only a part of which has as yet had the street lines and grades officially laid out. Nevertheless the office may be abolished in two or three years, as by that time all work will have been done and all information recorded, unless the city again extends its limits by taking in more of the suburban districts. At present there are two field parties at work, each consisting of four men, with a light wagon to carry tools, monuments, stakes, etc. The sewer and paving work are under the supervision of the Board of Public Works, which has its own engineer.

Among business firms there was a general complaint of hard times and lack of orders. This was partly due, no doubt, to the present general and widespread depression of trade, accentuated by the period of depression to which this country is subjected every four years in consequence of the uncertainty arising from the presidential campaign. These adverse conditions are made even worse, by the mistaken (though sincere) advocacy of the free silver policy which is now causing so much trouble. Of course, people living in a silver state, where a boom in silver would mean a certain activity in mining, may be expected to be prejudiced in favor of this particular metal, but this is a very narrow way of looking at the financial question, and it must be said that the arguments heard for "free silver" were neither convincing nor based on good or broad grounds. Considering that the silver production amounts to only about 4% of the total mineral products of the country (ranking with lime and building stone) it is not easy to see why this mineral should be given more attention and assistance than the other 96% in value of mineral products.

Colorado Fuel & Iron Co.—This company has its general offices at Denver, and its steel works, rail mills, etc., at Pueblo, 120 miles south, while it also operates extensive mines of anthracite and bituminous coal. The pipe mill makes cast-iron pipe of 4 and 6 ins. diameter, but in view of the growth of water-works, increasing demand for water-works supplies, and the high cost of freight, it would seem to be a good time to put in a plant for the manufacture of larger sizes of mains. The rail mill has turned out large quantities of rails for western railways, the present average demand being for rails of 70 and 75 lbs. per yd. They are said to be higher in phosphorus than is usually allowed, but to have proved to be good wearing rails, which is owing partly to the comparatively slow methods of manufacture. Some of the older rails for the Denver & Rio Grande R. R. had 0.13% phosphorus, although not more than 0.09% is now allowed. The company's Bessemer steel works were closed down about the middle of August, throwing some 400 men out of employment, and the following statement was issued by the president, Mr. J. D. Osgood, in regard to this action:

> All rail orders are filled, and the present unsettled business and financial condition of the country prevents the railways from buying rails for renewals, and all new enterprises are held in abeyance. All the other departments of the company's works at Bessemer are in operation, and will be continued so long as we can find a market for the products. Whenever new rail orders can be secured work will be renewed at the iron mines and blast furnaces. This action was taken without consultation with or suggestion from the directors or stockholders.

The American Water-Works Association is to hold its next convention at Denver, in 1897, and will certainly have very much of interest to examine in the extensive water supply system of that city, as will be seen by some notes made during a partial inspection of the works in company with Mr. Charles A. Allen, Chief Engineer of the Denver Union Water Co. These notes are too lengthy to be inserted here, but will be given separately in a later issue. In about two years the city will be supplied entirely by a gravity system, except for two high-service pumping systems on high summits. The system includes many miles of wooden stave pipe (with cement lined tunnels at summits), a large storage reservoir or lake, a sand filtration plant, etc., while the company also owns and operates ranches purchased with their water rights. There is a Venturi meter on the pipe line, with automatic recording apparatus, and among the proposed works is a large masonry dam in a mountain canyon to form an extensive reservoir.

Colorado Springs and Manitou.

At 7 p. m. on July 7, I left Denver by the Denver & Rio Grande R. R. for Colorado Springs, taking the New Mexico express (narrow gage), which runs through to Santa Fe, N. M. About ten miles from Denver is Fort Logan, a large U. S. military post which is just now a special center of attraction from the fact that Custer's cavalry is now stationed there. For some 30 miles the line runs along the plain, close to the slopes of the mountains, and then begins to ascend the Divide, reaching a summit at Palmer Lake, 7,237 ft. above the sea, and then descending to Colorado Springs, 75 miles from Denver, which was reached at 9.51 p. m.

This city is a most delightful place for rest and recreation, being 5,995 ft. above sea level, and having a wonderfully clear, invigorating and bracing atmosphere. The population is about 17,000. The streets are 100 ft. wide, and the avenues 160 ft. wide, and, with the exception of the few main business blocks, are almost all lined with good-sized trees, while Nevada Ave., the main street, has two rows on each side and two in the middle. Rushing and splashing streams of cold mountain water run through the irrigation ditches on each side of the street, there being usually a turfed strip between the sidewalk and the ditch. These ditches are mainly lined with plank, and have laterals extending to the gardens of the houses, plank gates being provided so that the water may be shut out of the laterals except for the length of time during which the owner is authorized to take water. Where new lawns have been made, the water is sometimes allowed to flood the entire lawn, to a depth of 1 or 2 ins., in order to thoroughly soak the underlying earth. Besides this system of garden irrigation, however, there is an almost universal and continuous use of lawn sprinklers, with the result that the houses stand amid beautiful velvety lawns and have their grounds rich with flowers and plants. In marked contrast to this richness are the occasional unoccupied and unimproved lots, on which the grass is a pale yellow and grey, burnt and scorched from the heat of the sun and the lack of water. This, on a small scale, is illustrative of the great changes which have been gradually wrought by irrigation, transforming what was practically a desert into a fertile and productive land. The great heat of a summer day is not oppressive, owing to the dryness of the atmosphere, but nevertheless on such a day the sight of the profusion of green and foliage and the sound of the rushing irrigation streams are most refreshing. The roads are well macadamized and kept in good condition for driving. The business blocks are substantial and of good appearance, and here, as at Denver, one is struck by the handsome appearance of the stores and the artistic way in which the goods are displayed. The water supply is obtained from mountain lakes on the slopes of Pike's Peak, and extensive works (including a long pipe line and a tunnel 6,000 ft. long, driven by electric drills) are now in progress for supplying water for domestic and power purposes, but as the present system and the new works were described and illustrated fully in Engineering News of Aug. 27, no further men-

tion thereof need be made here. The work is under the supervision of Mr. H. I. Reid, City Engineer. The city is close under the mountains, the most conspicuous peak, from certain points of view, being the celebrated Pike's Peak.

The city is rather inaptly named, since it has no springs, the springs being at Manitou, five miles distant. This is on a branch line of the Denver & Rio Grande R. R., but there is also an electric line, which, with its frequent service of cars takes the bulk of the traffic. The Colorado Midland Ry. has both Colorado Springs and Manitou on its main line. The early train on the Manitou branch is an accommodation train, and has the engine placed between the passenger cars and the freight cars. At the intermediate stations it pushes the freight cars onto a sidetrack, leaves those for the station, and then after backing out goes on up the main track to couple up to the other cars which are to be taken on, these cars having been switched onto the main track in front of the train. From the cars may be seen a portion of the "Garden of the Gods," with the curious isolated blocks, columns and masses of bright red rock, which are styled statues, pillars, cathedrals, etc.

Manitou, with a population of 1,800, is a pleasure and health resort situated on the slope of the mountains, 6,324 ft. above sea level, and is a very pretty place, populated mainly by tourists and invalids. Numerous springs of mineral water (soda and iron of various compositions) occur here, and at the largest there are pavilions where persons can sit and listen to the bands or stroll around and purchase photographs and various mementos of their visit. The most attractive spring to persons in good health (who taste nauseous waters merely in order to say they have tasted them) is the great Manitou soda spring, where soda water far superior to any of the manufactured varieties, bubbles up in a large basin or shallow well, and is distributed in glasses by the genius of the spring, in the form of a small boy clothed in everyday costume with the addition of a pair of high rubber boots. On the street may be seen men, women and children carrying bottles to be filled at the overflows from the springs. A large proportion of these bottles were made to contain various alcoholic liquids, and are not elsewhere carried openly in the streets. At Manitou, however, these suspicious-looking bottles are carried about in broad daylight with no attempt at concealment, the owners being conscious of the innocence of the contents, and therefore heedless of appearances. It was cynically suggested, however, that possibly the whiskey had been emptied into a jug and that the appropriate soda water was being carried home to impart medicinal properties to the mixture.

Pike's Peak Rack Railway.

At the upper end of the main street of Manitou and at the terminus of the electric railway, is the station of the Manitou & Pike's Peak Ry., the celebrated rack-rail line, which has been fully described and illustrated in Engineering News. It was built in 1889-1890. This line attains an elevation of 7,518 ft. in a length of about nine miles (47,992 ft.), having an average grade of 16% and maximum grades of 25%, and the summit being 14,147 ft. above sea level. The sharpest curves are of 16° (or 359 ft. radius). The scenery is most grand and picturesque, especially as seen from some of the long grades benched out of the side of the mountain, while the views from the summit are beyond descripton. It is, however, not such a thrilling ride in some respects as that up the old Mount Washington Ry., for the latter, though by far the shorter and reaching only to 6,293 ft. above sea level, has heavier grades and a number of long high trestles, while it is built among grim-looking grey and black rocks. The Pike's Peak line has no trestles and only four short plate girder bridges, and the rocks and scenery are of a more cheerful color and character than those of the White Mountains. As is well known, the Pike's Peak Ry. has the Abt rack-rail system, with double rack bars (the teeth of which are lapped or staggered lengthwise of the track), while the Mount Washington Ry. has the old ladder rack of the Marsh system, which is erroneously known in Europe as the Riggenbach system. The teeth of the rack-bars show very little wear beyond a slight burr on the top of the up-grade face, indicating the flow of metal under pressure.

The running track is laid with 40-lb. rails, having square three-tie joints spliced with 38-in. angle bars and six bolts, but owing to the creeping of the rails some of the joints are now suspended. There are 18 pine ties to a rail length, and a row of planks is laid on the ties on each side of the rack-rail, the planks being double spiked to each tie. The ballast is of disintegrated rock, shouldered out beyond the ends of the ties. The track requires constant attention, and there are two section gangs, one of eight men and one of five men. The track gages are marked for the position of the rack-rail. There is not now much trouble from the creeping of the track, the banks having become consolidated and the anchorages having come to a heading. Near the Halfway House were seen the works for the Colorado Springs water supply plant, above referred to, and a view taken at this point was shown in Engineering News of Aug. 27. At the summit is a stone building containing a refreshment room and a room full of souvenirs, but there is no hotel accommodation. A few small patches of snow were seen in crevices of the rocks at the summit. An example of great carelessness was noted near one of the water tanks, where ashes had been dumped and shoveled outside the rail in a pile so high and so near the track that the big end of the main connecting rod on that side struck full into the heap of ashes. None of the men seemed to take any notice of this, however. Each train consists of one long four-wheel car, seating 50 passengers, and a Baldwin four-cylinder compound locomotive, having cylinders 9×22 and 15×22 ins., four main carrying wheels 25½ ins. diameter and two double pinions, 22½ ins. diameter, for the rack. The engine has a two-wheel truck under the cab. Its weight is 45,850 lbs., with 33,200 lbs. on the driving wheels. The cars have rack pinions for braking purposes. The engine pushes the car up the mountain, and is not coupled to it, the contact between the engine and car consisting of a vertical roller on the front of the engine bumper beam bearing against a horizontal roller on the rear of the car platform. The speed is low, the up trip occupying 1 hour 50 minutes and the down trip 1 hour 30 minutes, with five intermediate stops on each trip. An interesting device seen at the Halfway House was the "toboggan" or "go-devil" on which a man occasionally descends the line, sliding on the rail and having a wedge brake gripping the rack-rail. I have seen such a device used on the Mount Washington Ry., the descent being made at terrific speed.

(To be continued.)

THE PECOS VALLEY IRRIGATION SYSTEM.

By L. B. Howell, M. E.

The valley of the Pecos River in southeastern New Mexico is the site of an irrigation system having at present under its operated canals some 200,000 acres of land. The source of water supply is the Pecos River, across whose bed two dams have been thrown, as shown by Fig. 1, designed for an aggregate storage capacity of 3,900,000,000 cu. ft. The smaller dam, situated six miles above the city of Eddy, was built in 1889-90. A brief description of this dam was given in Engineering News of May 17, 1890. The principal dimensions of the structure were as follows: Length, 1,040 ft.; greatest height above bed-rock, 40 ft.; top of dam, 30 ft. above floor of headgate channel. The dam was rock-filled, having on its up-stream side a rough wall of rock laid with the slope of ½ to 1. Outside of this wall earth was placed to a slope of 2 to 1. This surface was protected by rip-rapping. The slope was afterwards changed to 3 to 1, the original earth facing being washed out. On the down-stream side the limestone filling was allowed to take its natural slope, 1 to 1. Fig. 2 is a general view of the dam and Fig. 3 is a cross-section of it, as rebuilt.

At the eastern end of the dam, at right angles to it, was cut a rock channel, containing, respectively, at its end and side the headgates of the canal and the spillway gates for discharge into the river below the dam. Fig. 4 is a view taken from the dam at a point near its east end, showing secondary headgates, and two spillways. The main headgates are 4 ft. wide by 8 ft. high, sliding in vertical guides and operated by screws from a platform above. The upper spillway, Fig. 5, contains 31 gates, 5 ft. ½ in. in width by 7 ft. 2 ins. in height. These gates, when open, discharged at 13 ft. above floor of headgate channel, and when closed, discharged at 10 ft. below top of original dam. Fig. 6 shows the details of a spillway gate, with its releasing apparatus. Each gate is hinged to swing horizontally and is unlatched by a blow on the vertical releasing rod. When the gates are to be closed, the water is diverted by flash-boards, dropped above the gates. Below the main headgates is a set of secondary gates for diverting the water through the lower spillway, which is 61 ft. wide. At the west end of the dam, a spillway, 200 ft. in width and having no gates, was cut in the rock. It discharged water at 7 ft. below top of dam.

A feature of the construction was the tunnel or

Fig. 1.—Map of Pecos Valley Irrigation System, Eddy, N. M.

scour channel piercing the dam at a point near its eastern end, and at a depth of 9 ft. below the headgate channel floor. A gate was placed at the upper end of this scourway and was operated by a vertical screw 36 ft. in length.

It will be seen from the above description of the dam, that its safety depended entirely upon the ability of the spillways to keep the water below its crest. No attempt was made to build a structure able to withstand an overflow. In August, 1893, a heavy flood caused the destruction of the dam, because of the insufficiency of spillway capacity. The water rose steadily, despite the heavy flow through the spillways, and finally poured over the dam, quickly carrying it away. In rebuilding, the height of the dam was increased 5 ft. and its length to 1,135 ft. Its cross-section is shown in Fig. 3. The capacity of the west spillway was increased by cutting it down 3 ft., and widening it to 240 ft. A second rock spillway on the west was

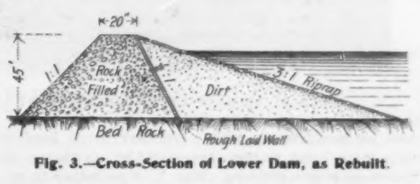


Fig. 3.—Cross-Section of Lower Dam, as Rebuilt.

added, having a width of 300 ft. Both now discharge at 15 ft. below top of dam, at the same level as the upper spillway at the eastern end of the dam (gates closed). The scourway was found to be of no value and was removed in the rebuilding. The present dam forms a reservoir of 300,000,000 cu. ft. capacity, at the level of the top of the upper spillway gates.

In 1893 was commenced the second and larger dam. Following the windings of the Pecos, it is situated eleven miles above the lower dam. It is

similar in construction to the latter, but of greater length and height, the dimensions being, respectively, 1,835 and 56 ft. As in the present lower dam, the top is 35 ft. above the floor of the headgate channel. Water is diverted into a rock-cut 1,100 ft. long, through headgates, and back into the river bed, which serves as a channel leading to the lower reservoir. The upper end of the rock-cut channel and the headgates are shown by the view, Fig. 7. The headgates are six in number, 4 ft. wide by 8 ft. high. At present water is stored to a depth of only 18 ft. above floor of headgate channel. This level will, however, eventually be raised to 25 ft., or 10 ft. below top of dam. A long earth embankment in continuation of the dam on the west, was built along the shore of the reservoir. At present it contains a spillway 400 ft. wide, which discharges at the 18-ft. storage level, or 17 ft. below top of dam. The capacity at the 25-ft. level will be 3,600,000,000 cu. ft., 8,100 acres to be submerged.

The lower reservoir has its outlet in a single canal, the first section of which, following the east bank of the Pecos, 3.2 miles, has the following dimensions: Forty-five ft. wide on the bottom, with 7 ft. banks, having a slope of 1½ to 1; capacity, 400 cu. ft. per sec. At the end of the first section, the canal branches, the main portion continuing southward, and a smaller ditch leading in a wide bend to the east of Eddy, as shown on the map accompanying, Fig. 1. The latter is operated at present for a distance of four miles and is completed for 16 miles. Its capacity is 150 cu. ft. per sec. The main branch is in operation as far as the point marked (A) on the map, 31 miles below the lower reservoir, its width on bottom varying section by section from 30 ft. at the point of junction with the "East Side" canal, to 15 ft. at its terminus. The grade of the canal is 1½ ft. to the mile throughout. The Pecos River is crossed on a wooden flume, 468 ft. long by 25 ft. wide. The Black River, 28 miles below the reservoir, is crossed on a similar structure, 1,028 ft. long by 16 ft. wide. Laterals are cut in at frequent intervals and cover the whole area eastward from the canal to the river, a distance which reaches a maximum of about five miles.

Distinct from the system of reservoirs and canals described above, but under the same management, is the "Northern" canal, carrying water to the town of Hagerman and the vicinity. This canal derives its supply from a group of springs situated near Roswell, 90 miles north of Eddy, and forming the source of the Hondo River, a tributary of the Pecos; no storage is attempted. The flow is diverted into the canal by a small dam and continues southward a distance of 38 miles, varying from 120 to 300 cu. ft. per sec. during the rainy season. The grade of the canal is 1 ft. per mile. Nine-Mile Creek is crossed on a wooden flume 330 ft. long by 25 ft. wide. Felix Creek is a dry, rocky bed, except in periods of heavy rainfall, when it becomes a stream of considerable width. An earth embankment 1,000 ft. long and 23 ft. high is thrown up across the river bed. It acts as a dam and as the lower bank of the canal. In each end of the embankment is cut a weir 10 ft. deep through which flood waters escape. The waters of the canal spread out into a small lake at this point, there being no upper bank. The same plan is followed in crossing a dry stream at a point on the southern canal, except that a single weir is cut in the center of the embankment.

When subjected to irrigation, the soil of the Pecos Valley is found to be exceptionally fertile. Fruits, grains, vegetables, all thrive. The land under the canals is controlled by the Pecos Irrigation & Improvement Co., whose headquarters are at Eddy. Water is brought to the boundaries of the farm by the company, all ditches outside being maintained by it. Each section of the canal is in charge of a "ditch-rider," whose duties consist in the maintenance of canal and laterals, the supervision of the supply to the farmers, and, in general, the rendering of assistance and advice to the latter in methods of irrigating. Telephonic connection is maintained between the offices of the company and all parts of the system, including the two reservoirs.

The storage capacity of the two reservoirs is sufficient to supply all the land under the present length of southern canal, as it is gradually placed under cultivation. In all but four months of the year, March, April, May and June, the storage is not now drawn upon, the natural flow of the river being sufficient for the demand during the remainder of the year. An extension of the system will involve the construction of other reservoirs at several points in the Pecos. The first one to be undertaken would probably be situated between the two present reservoirs, as shown on the map by dotted lines. Two other sites have been located, one near Red Bluff, and the second above Riverton, Tex., a canal to be taken out at the latter point.

For the information contained in the above descriptions, the writer is indebted to L. H. Bartlett, Superintendent of Water Service of Pecos Co., Eddy, N. M.

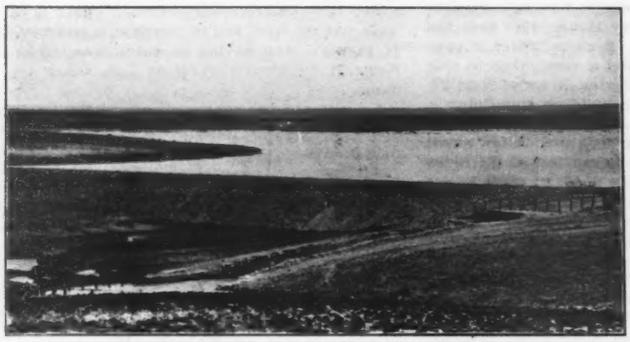


FIG. 2.—VIEW OF LOWER DAM FROM THE SOUTHWEST.

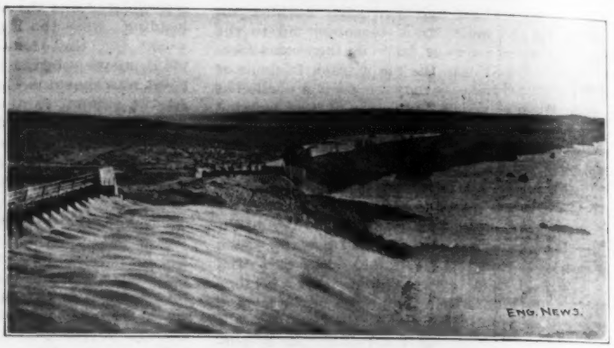


FIG. 4.—VIEW OF SPILLWAYS AND SECONDARY HEADGATES, LOWER DAM.

FIG. 5.—VIEW OF UPPER SPILLWAY AT LOWER RESERVOIR.

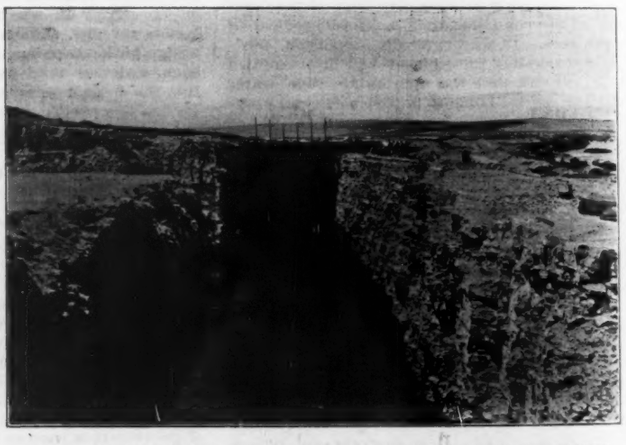


FIG. 7.—ROCK CUT CHANNEL BELOW HEADGATES AT UPPER RESERVOIR.

TESTS OF FIREPROOF MATERIAL.

A test of the Roebling fireproof construction system for floors and partitions of buildings was made in New York on Sept. 3, under the supervision of the Department of Buildings. This system has wire netting embedded in cement or concrete, the floors having the netting in the form of an arch between the lower flanges of the floor beams, and sometimes having a flat ceiling composed of a layer of netting attached to the flanges of the beams and covered with cement and plaster. The system was described and illustrated in our issue of July 18, 1895, and May 14, 1896, and is being introduced by the John A. Roebling's Sons Co., 117 Liberty St., New York city, this firm having already applied it in several large buildings.

A small steel skeleton building was erected on a vacant lot at 82d St. and Western Boulevard, hav-

ing grates for the floor, and having the roof formed of the Roebling arched and flat-ceiling construction, besides which there were two partitions extending from the walls. The fires were lighted at 11:10 a. m., the temperatures inside the structures being recorded by a Uehling & Steinbart pyrometer (Eng. News, Nov. 14, 1895), and ranged as follows:

	Degrees.		Degrees.
11:26 a. m.	1,150	Noon	1,990
11:30 "	1,300	12:01 p. m.	2,000
11:37 "	1,600	12:02 "	2,025
11:42 "	1,800	12:03 "	2,050
11:53 "	1,800	12:04 "	2,100
11:55 "	1,900	12:05½ "	2,125
11:59 "	1,950	12:07 "	2,150

About 12:45 a detachment from the fire department extinguished the fire, using a single hose, the principal damage done being the falling of plaster from the wire, leaving the netting exposed, though the concrete above it still carried the load of bricks piled upon it before the commencement of the tests. One partition, with a single sheet of netting, had collapsed and was nearly stripped of its plaster covering; while the other, with two sheets of netting, though distorted and cracked

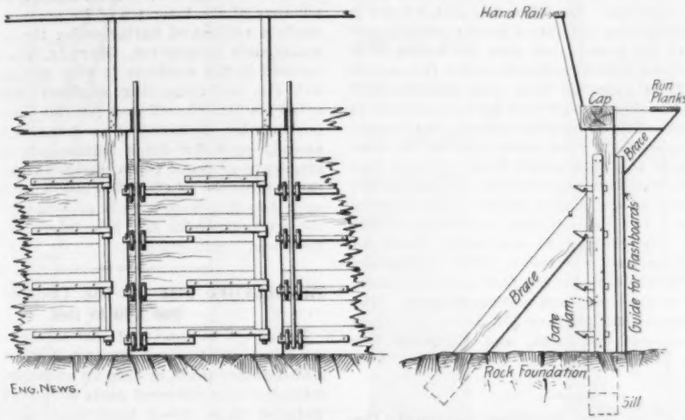


FIG. 6.—DETAILS OF SPILLWAY GATES.

was still practically a partition. Some of the ceiling plaster fell from the wire during the fire, and some was knocked off by the stream of water from the fire hose.

In another brick building, 10 × 11 ft., with half the roof formed on the Roebling system and the other half being 10-in. hollow tiles, all set between 10-in. I-beams, a fire was lighted in the same way, and maintained from about 11:07 a. m. to 12.30 p. m., when it was extinguished by the firemen. On each of these floor arches was a load of bricks of about 9,000 lbs. on a space 4×4 ft., but neither arch showed signs of collapse, though some of the netting of the Roebling arch was exposed by the falling off of the plaster.

After the structure had cooled down the Building Department examined the structure to note deflection of iron work and any other interesting facts connected with the test. It was then ascertained that the iron beams supporting the floors over which was placed the safe load of 150 lbs. per sq. ft., had not deflected, or at least the deflection was so small that it was imperceptible on the readings of the level rod. It was also found that the partitions had buckled through having been placed directly under the iron beams of the floor above and fastened to the brick wall below. There was no chance for expansion and the buckling was a necessary consequence when the heat caused the iron in the partition to expand. Some of the intermediate studs in the partitions were buckled in the form of an S. In one case, where no flat ceiling and air space were used, the wire netting of the arch was practically destroyed, but the iron and concrete of the floor are considered amply strong to carry any safe load, so that in a building there would be no need to rebuild the floors because of the destruction of the netting. In the other building the Roebling floor is said to have shown no deflection, while the flat floor showed a deflection of about ⅝-in. The floors will shortly be tested to destruction by loading.

A similar test was made on Sept. 10 of the system of floor construction manufactured by the Fawcett Ventilated Fireproof Building Co., Ltd., whose main offices are at 448 to 450 Bourse, Philadelphia. This system was illustrated in Engineering News of April 9, 1896 (page 235, Fig. 8). Steel beams are used a uniform distance of 2 ft. apart. Terra cotta lintels of a hollow cross-section are supported on the lower flanges of the beams in such manner that the under side of the lintel is about 2 ins. below the beam. An air space is thereby formed between the lower flange of the beam and the base of the lintel. Above the lintel the space is filled in with concrete.

The test was made in a brick building erected for the purpose, on a lot at the corner of 68th St. and Ave. A. The building was 14 ft. × 11 ft. inside, by 10 ft. high. The roof was formed of the Fawcett floor, 6-in. beams being used, running lengthwise of the building, and the floor being designed to carry safely 150 lbs. per sq. ft. A small chimney was placed at each of the four corners of the roof and a grating was fixed near the bottom, covering the whole inner area. The ceiling was made of common plaster laid directly on the bottom of the lintels, which were grooved with dovetails so as to retain it. Several cords of wood were placed on the grates, some kerosene was sprinkled on it, and the fire was lighted at 9.33 a. m. By 10.30 the pyrometer had reached 1,850° F., and the maximum temperature of 2,200° was recorded at 10.50 a. m. At 11.10 a. m., the wood having partly burned out, the temperature had gone down to 2,000°. The walls of the building had by this time cracked badly from expansion of the brick on the inside. More wood was put in between 11.20 and noon, but the temperature could not be brought higher than 1,850°. When the maximum temperature of 2,200° was reached, the roof, which had been loaded with brick on the two central panels to 150 lbs. per sq. ft. had sagged down about 4 ins., due apparently to expansion of the lower flange of the beams by the great heat. At 12.20 p. m. water was thrown into the building by the Fire Department, the stream of 60 lbs. pressure being directed against the ceiling. When the building had been cooled sufficiently to allow persons to enter it was found that the only damage done was the sagging of the beams, the removal of most of the plaster, and the breakage of the base of several of the lintels. The concrete above the lintels remained in place. On Sept. 11 the test was continued without fire, by adding to the load on the two central panels of the roof up to 600 lbs. per sq. ft. without any further damage being visible. During the fire test the fire did not break through the roof at any point, and the upper surface remained so cool that the hand might be placed upon it.

TELEPHONE WIRES IN WATER-WORKS TUNNELS AND SUBMERGED PIPES.

The importance of prompt means of communication between points on water-works systems separated by water, like intake cribs and pumping stations is obvious. Telephonic communication is maintained at two places of which we know, Chicago and Vancouver, B. C., and doubtless at some others.

The extent of this sort of telephonic communication in Chicago is stated in the following letter from Mr. John Ericson, Assistant City Engineer, written on Sept. 4, 1896:

The old Chicago Ave. crib, the Four-Mile crib and the 68th St. crib are the only ones so far connected with telephones. The wire to the Chicago Ave. crib is laid in the tunnel and the one to the Four-Mile is also laid in the tunnel. The latter cable was laid part of the way by means of hoisting engines and wire rope, but this being found to be a slow and expensive way, the balance of it was laid by men carrying the cable through the tunnel. This cable has been in good condition since laid in 1892.

The one to the 68th St. crib was laid by means of hoisting engines and wire ropes placed on both the intermediate and the outer cribs. This cable worked satisfactorily for a few months, when it gave out entirely. As it was impracticable to make any repairs to the cable, a new cable was laid on the lake bottom to the crib; this cable is now being used. At Lake View there is no telephone connection as yet, but a cable similar to the one at 68th St. will probably be laid from the pumping station on the bottom of the lake to the crib in the very near future.

The telephone cables at Chicago consist of three wires insulated and wound with hemp, apparently tarred hemp, and then wound with a cover of metal wire of about the size of a telegraph wire.

At Vancouver a telephone was laid in a submerged pipe in a manner which cannot be set forth to better advantage than by the description of the work, kindly sent at our request by Mr. Thos. Tracy, M. Can. Soc. C. E., City Engineer of Vancouver, as follows:

The pipe through which our telephone cable was laid was of cast iron, 12 ins. in diameter, with flexible joints, and was put together on ways on the north side of Burrard Inlet and pulled over by means of steel cables from capstans on the south shore. In order to lessen the strain on the joints a steel cable, 1¼ ins. in diameter, was placed in the pipe and cinched up tight at each end. When the pipe was in place on removing this cable a No. 16 wire was attached to the end and drawn into the pipe.

When ready to put the telephone cable in, the No. 16 wire was replaced by a No. 6 galvanized wire and by this the cable was drawn into the pipe.

The cable used was a No. 12 copper, insulated, covered with lead and braided on the outside. The strength of it was barely sufficient to stand the strain of pulling in 1,600 ft. in length. For a greater length a stronger cable or a steel armor on it sufficient to stand the pulling strain would be necessary.

If the distance be not too great a line with a number of floats, decreasing in size from the front, attached throughout the length would probably answer. The line could be changed until one was in sufficiently strong to haul the cable.

I would suggest that an additional smaller (loose) wire be drawn in so that in case of a breakage in the hauling wire or cable the whole of the work would not have to be gone over.

At Toronto, Ont., the laying of telephone cables in the submerged pipes across the bay has never been attempted, but telephone service to the island is maintained. Mr. E. H. Keating, M. Am. Soc. C. E., City Engineer of Toronto, describes this service as follows:

Our telephone service to the caretaker's residence on Toronto Island and the island pumping station is maintained by means of a submerged cable across Toronto harbor. We also have an electric alarm bell at the main pumping station in the city which indicates the limit to which the water is allowed to be drawn down at one of the connecting cribs across the harbor. This service is also operated by means of a submerged cable.

It was once proposed to place a telephone cable in the water intake tunnel at Cleveland, while the intake was in use, but Mr. M. E. Rawson, Chief Assistant Engineer of the Department of Public Works, informed us that the project had not been carried out, but he considered it feasible to do so.

We have been unable to find any other instances of laying telephone wires in submerged pipes or in water-works intake tunnels. Telephone service along pipe lines is maintained in several instances, notably in connection with the water supply of Covington, Ky., and Newark, N. J.

A PHOTOGRAPHIC SURVEYING CAMERA is said to be used with advantage in India, which photographs on the same plate with the picture the magnetic bearing of its central vertical plane. This camera is mounted on a tripod, with leveling screws, and turns on its axis on a horizontal plate with a graduated rim, permitting horizontal angles to be read when desired. On the top of the camera-box is a level and a telescope, with an arm for taking vertical angles. The vertical cross-wire of the telescope bisects the ground-glass screen of the camera. A second vertical wire inside the camera is on the same vertical plane; and the shadow of this second wire is shown upon the plate when developed, making the center-line of the picture. Behind this second wire is a compass, mounted on a rack inside the camera, by which it can be made to just clear the plate when a picture is taken. The graduation of the compass card is carried out on a vertical strip of translucent material through which the light passes to the plate, thus photographing the compass bearing on the plate. A horizontal wire is also photographed on the plate, showing on the picture the true horizon, when the instrument is properly levelled.

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The classic definition of civil engineering in the article on "The Artistic Element in Engineering," in our issue of Sept. 10, was ascribed by the author to Telford, as is usually done, but Prof. Marvin writes us that he has learned that Tredgold was really the author of that definition.

The tests of fireproof floors which are now being made by the Department of Buildings of New York city, will, it is expected, lead to an important increase of knowledge respecting the safety of the so-called fireproof high buildings. The credit for the inauguration of this series of tests is due to Mr. Howard Constable, M. Am. Soc. C. E. He has for the past year or more been studying the subject of fireproof flooring and the methods of testing, and has induced a number of manufacturers to construct samples of their flooring and turn them over to the Department of Buildings for test, according to methods which he has prescribed. The present building law of New York city prescribes that the spaces between all iron or steel floor beams in fireproof buildings shall be filled with common brick or stone arches, or with "sectional hollow brick or hard burned clay, porous terra cotta, or some equally good and fireproof material." Mr. Constable's object is to construct a terra cotta floor which when loaded with its full allowed or safe load shall withstand an intense fire for several hours, and then a stream from an ordinary fire engine without being destroyed or letting its load fall through. When it has been found that a floor of the ordinary terra cotta construction, of sufficient lightness, reasonable cost and good appearance, can be made to stand such a test, then a standard of endurance under test will have been reached to which all the newly proposed styles of flooring will have to conform before they can be allowed by the Building Department.

Our present knowledge concerning the strength and fire-resistance qualities of different floor constructions is exceedingly imperfect. Probably less is known by architects and structural engineers regarding the safety of floors than of any other portion of a building. In Mr. Constable's earlier tests of strength of floors he found factors of safety ranging all the way from 1⅝ to 20. The relative cost of the steel beams in a floor, as compared with the terra cotta or other filling has caused some builders to go to an extreme in increasing the spans between beams, thus greatly increasing the risk of destruction by fire, even though there may be ample strength in the absence of fire. It is to be hoped that the tests now in progress will, among other things, lead to the establishment of rules which will fix the maximum spans for floor sections, and of standards of workmanship for the terra cotta or other filling material.

The tearing up of asphalt pavements for the laying of subway, water and gas pipes, and for sewer connections, is one of the knottiest problems with which the public works departments have to deal. Builders have a right to these connections which cannot be abridged, and corporations obtain rights for street disturbance which the city authorities find it difficult to combat. While it is usually made compulsory to obtain a permit for such work and the parties are compelled to restore the pavement in kind after the break is made, the filling put in almost invariably settles in time and the street surface sinks with it, leaving a long hollow in the pavement. The attempt is now being made in several large cities to appeal to the pockets of the offending parties by making the cost of repairs as excessive as is reasonably possible, in the hope that this cost will discourage any but the most necessary openings. Brooklyn has just framed a regulation requiring not only a proper refilling and ramming of the trench, but also the laying of 8 ins. of Portland cement concrete under the paving surface. It is expected that this concrete will bridge the opening and prevent surface settlement even when the filling beneath does sink. But the new regulation also adds most materially to the cost and nature of the repairs and tends to place this work in the hands of experienced and responsible men, rather than to divide it, as now, among many contractors. Incidentally it may be mentioned that New York city charges $4 per square yard for opening an asphalt pavement, with a minimum charge of $16; and $8 for the first yard of granite pavement—and $4 for each additional yard. The city of Philadelphia charges $13 for a permit to open an asphalt pavement, and increases this amount to $18 between Dec. 1 and March 1 in any year.

In commenting upon horseless carriages, the "Horseless Age," of London, states that it does not believe that any fairly satisfactory vehicle of this type has yet been produced, and gives its reasons as follows: The experiments in France and elsewhere prove that light-oil engines can be used for purposes of locomotion, in this connection. But no vehicle has yet been designed to burn heavy oils without producing a disagreeable smell. The carriages which have made successful runs burn petroleum spirit, benzine or naphtha; materials which necessitate the storage and carriage of a highly inflammable liquid; which does not comply with the laws usually in force, and would make trouble with the insurance companies. The man who is called upon to invest about $1,500 in one of these carriages will properly demand that it be safe, odorless and free from vibration, or comfortable. And the trials of horseless carriages so far made prove that these conditions cannot be secured; in other words, the horseless carriage is not yet a commercial success. Those interested in the design and operation of these carriages, from an engineering point of view, are well aware of these defects, and are striving to remedy them; but others who believe that a finality has been reached and that investment in every horseless carriage scheme that presents itself is a short and sure road to profit, would do well to await further developments.

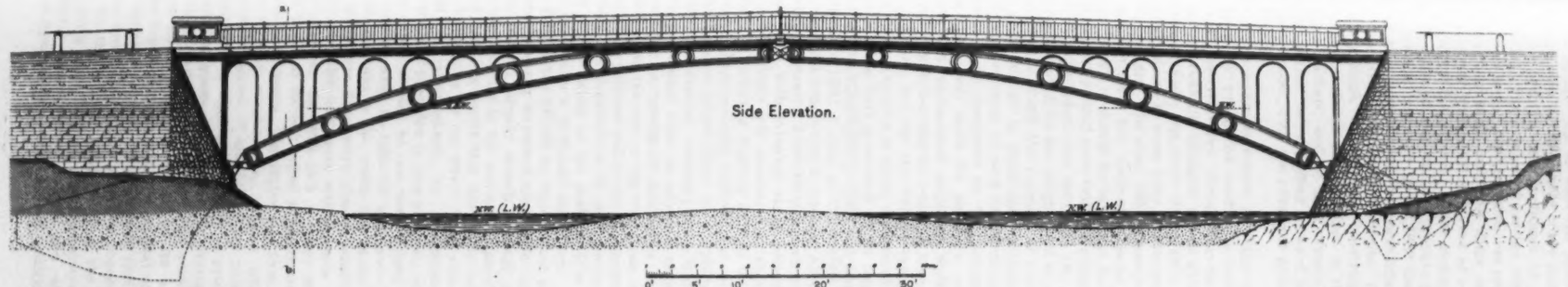
For some time past engineers in this country have been receiving circulars, inviting them to invest in the shares of the "Civil Engineers Exploration Syndicate, Limited," of London, and these papers eloquently set forth the advantages of this connection. Engineers are told that members introducing business to the syndicate, in the form of patent processes, concessions, contracts or other enterprises relating to the business of an engineer, will be entitled to a bonus of ten per cent. from any net profit derived by the syndicate. Throughout the documents the name of the Institution of Civil Engineers figures prominently, and the Council of that body now issues a circular letter to its members stating that this use is unwarranted by any official action of that body, and it disapproves of the formation of any such syndicate or company because it believes that such a combination among its members, for the purposes set forth, would be undesirable in the true interests of the profession. The chief objections we see to any such organization are that any one can join its ranks, without reference to previous experience or character, and the temptation is held out to weak engineers to indulge in what is properly termed unprofessional conduct. On the one hand, subscription to the shares constitutes membership and enables any designing or unprincipled party to participate in its operations, or, perhaps, to direct them in time. On the other hand, the interest of the syndicate in a patent process, for example, is made the interest of every member of the syndicate, and the temptation is at least strong to recommend the adoption of this process regardless of the true demands of engineering conditions and unbiased professional opinion. An engineer is also often necessarily intrusted with the preliminaries of very important business enterprises, the divulgence of which, in advance of the interests of its promoters, may be made a subject of barter under the terms of the syndicate's prospectus. Happily, the trust thus reposed in the engineer is very seldom betrayed; but the self-respecting engineer will carefully avoid placing himself in a position where he could possibly be suspected of so doing. Channels are already open for doing legitimately all that the syndicate proposes to do, and with the Council of the Institution of Civil Engineers we believe that such an organization as is proposed is opposed to the true principles and best interests of the profession of engineering.

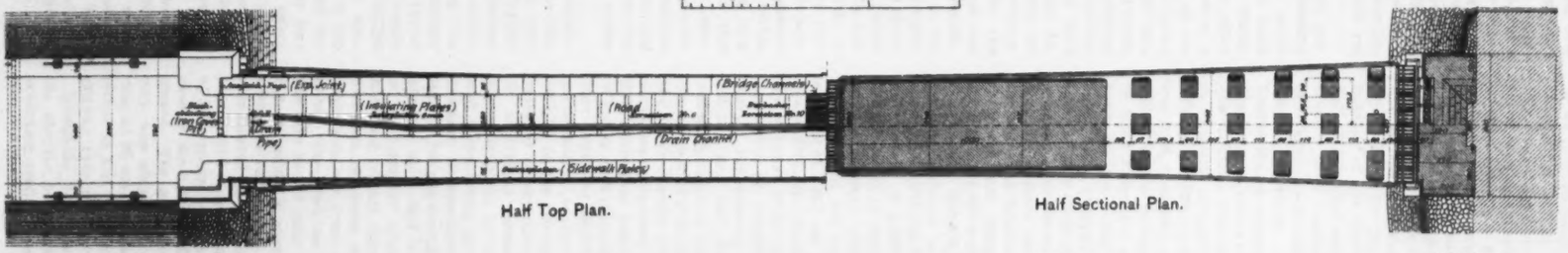
THE RELATIVE SIZE OF THE TRADING WORLD IN 1860 AND IN 1896.

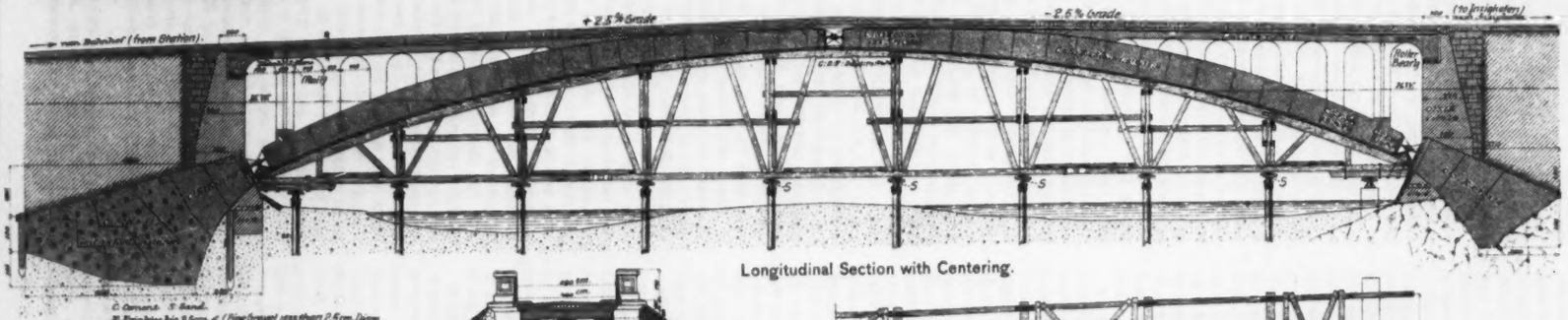
Reduction in time and cost in the transport of goods are the two important factors in promoting international trade, or even an exchange of commodities between different parts of the same country. Both of these items have been enormously reduced within the last thirty years; and the relative distances between trading centers have decreased to such an extent, as compared with the available means of a generation ago, that the world may be said to be much smaller now than then. For all trade purposes San Francisco, at the present time, is about as near to New York as St. Louis was in 1860, and the events and issues of all nations, political, commercial and financial, are known to us almost as soon as they happen. The forces at work within this period have tended to unite the various divisions of the earth to such an extent that anything seriously affecting one part must be felt throughout the whole; and this unity of interests should be taken into consideration in any attempt to deal with problems brought about by a universal and radical change in conditions.

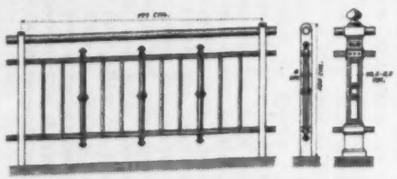
The law of trade is a natural law of supply and demand that expands with the facilities for manufacturing and exchanging goods; and the causes that operate and produce effects in a limited field will extend over a wider territory just as the means for so doing are developed. Within the period in question our scientific, engineering and general material advance has been phenomenal in the history of the world; and it is with this advance that we now have to deal as typified in the effect upon commerce of the extension of railways, the growth in sea tonnage and the shortening of routes of trade.

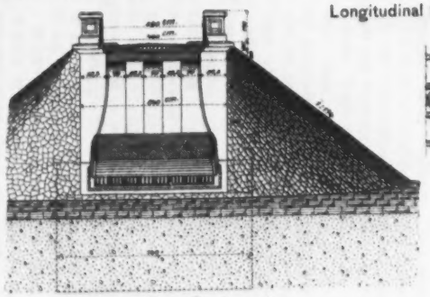
If we take any date anterior to the introduction of railways, or previous to 1825, we may safely consider each nation separately, from a manufacturing and trading point of view. Each supplied its own wants, mainly from material and labor within its own borders, and was little affected by what its neighbor was doing in a similar line. Foreign trade was practically confined to the import of the luxuries of life and commercial rivalry could hardly be said to exist; at least, from the present point of view. Without railways at all and with highways in a generally very bad condition intercourse was limited within the

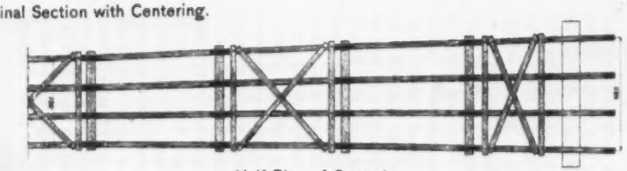


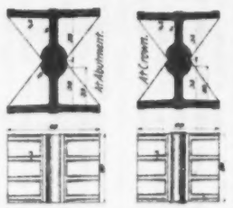








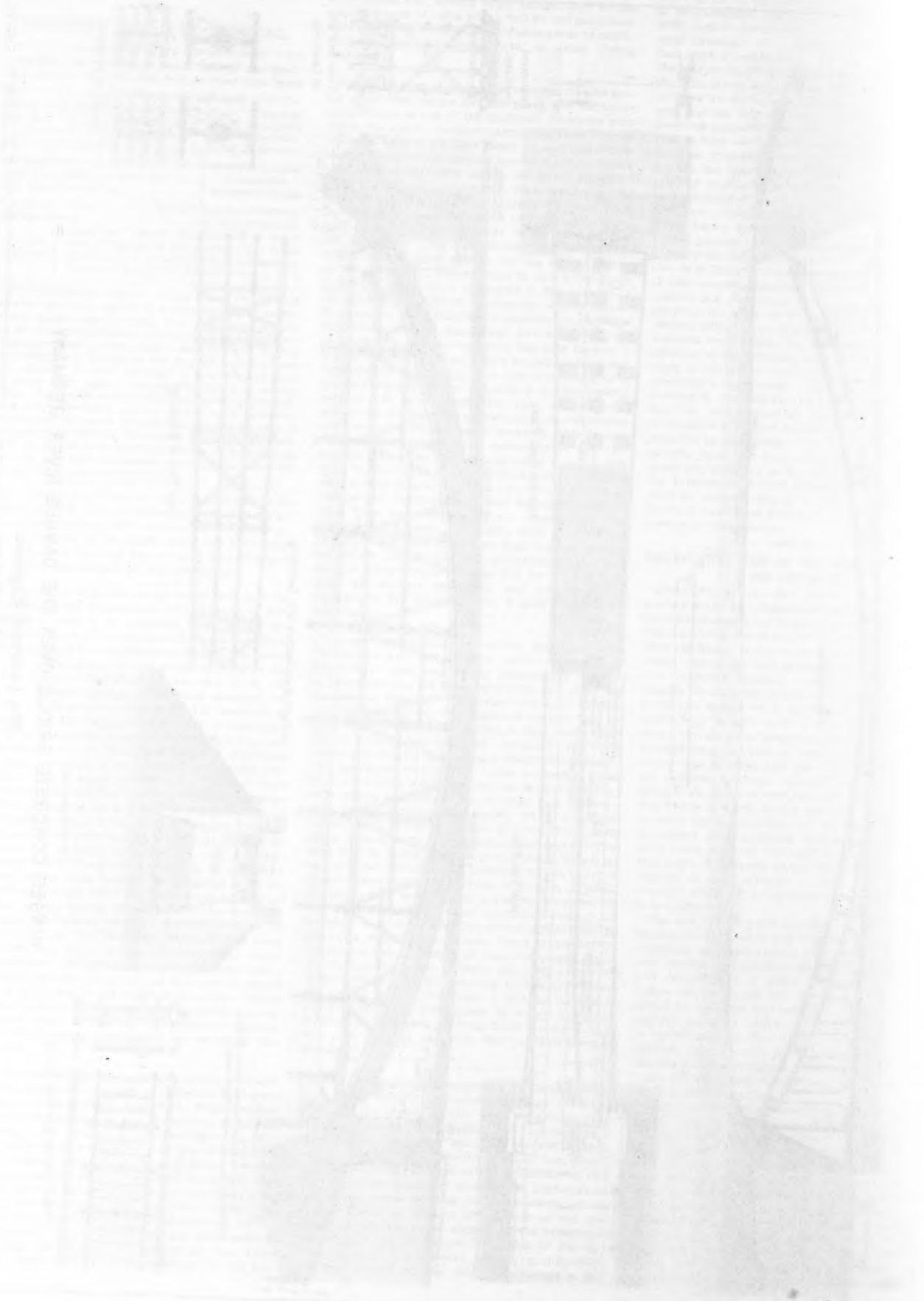




HINGED CONCRETE BRIDGE OVER THE DANUBE RIVER, GERMANY.

Max Leibbrand, Engineer.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.



boundaries of any one state; and the centralization of population, so characteristic of the present age, was impracticable, owing to the lack of means for supplying such centers with food and other necessaries of life. Up to 1825 the processes of manufacture were still generally crude and closely followed the practice and traditions of a more remote period. The volume of foreign trade was then relatively large; but this trade was conducted in comparatively small and slow ships and over seas imperfectly known. The advent of railways and the gradual development of the steam engine and of processes of manufacture brought about a decided change; but even up to 1860 the broad effects of this change were only beginning to be felt, as compared with present events. Clipper-built sailing ships 34 years ago outstripped the paddle-wheel steamers on the ocean in the race for foreign markets; and on land railways were, to a large extent, being pushed forward into undeveloped regions, with the resultant growth yet to be realized.

It is not necessary to review in detail the several stages by which the conditions controlling trade and manufactures throughout the world have been so radically changed within little more than three decades; but some comparative statistics will enable us to more fully realize the effect of these changes. The year 1860 is selected as a somewhat arbitrary but convenient point of departure; though it should be said that the forces that have since yielded such brilliant results were quietly at work before that date and the ground was being prepared. In any comparison of relative progress in the world the increase of population comes first; because in these more peaceful days this increase compels as well as encourages development in all directions by the necessity for finding food and work for the new millions. Scientific and engineering progress, within the dates mentioned, has had its origin in Europe and North America, and for this reason the population of these countries is alone considered in the summary to be here presented. This aggregate population was 322,600,000 in 1860, and was about 446,000,000 in 1890, a gain of 123,400,000 people in 30 years. The population of Asia and Africa, now estimated at nearly 1,000,000,000, had little or nothing to do with bringing about present progress; but it enters into commerce as an important factor in inducing western nations to manufacture for these teeming millions and to utilize the cheap labor found there in supplying raw materials for general consumption. Were this Eastern population ever to advance to a competitive point in intelligent productive capacity, the effect upon the rest of the world can only be guessed at by political and social economists; and that there are possibilities in this direction the sudden rise of Japan to the position of a power among nations is a sufficient indication.

This gain of 123,400,000 in the civilized population means a vastly increased productive capacity; but, for reasons already stated, without a corresponding increase in the means of manufacturing and handling goods this growth in numbers would have little or no effect upon commerce, national or international. In considering the means actually provided in this interval, railways may be safely classed as one most potent factor in the new growth. In 1860 the aggregate length of all the railways in the world was about 66,290 miles, and these lines were almost wholly confined to the older and more settled parts of the world's surface. In 1893 this mileage had increased to about 390,000 miles, a practically six-fold gain in 33 years. The immediate local effect of this railway construction, coupled with the general development of manufacturing processes, was gradually to decrease the cost of producing and handling goods and vastly to increase the comforts of travel and of living. But aside from this and almost more important in its bearing upon the world at large, was the gradual opening up to civilization and to cultivation of vast areas of what was previously waste and inaccessible lands. To the railways built west of the Mississippi River since 1865 we owe the mineral and agricultural development, which has already added so enormously to our national wealth. And to the extension of railways into the heart of the Argentine Republic, into India and Russia and now across Siberia, we are indebted for a rivalry in the markets of the world that has materially reduced the profits upon our own grain and cotton. In several of these sections development upon modern lines has only commenced, with railways as a basis of operation, and what the ultimate productive capacity of these regions may be we have no means of even estimating. Our only consolation is that the consumers are also rapidly increasing throughout the globe, and it is a fairly well established law that the volume of the product consumed increases with the advance in civilization and even faster than the means for supplying the demand.

When the direct local effect of railway extension upon trade is to be considered, we can best study this in our own country where fuller statistics are available for this purpose. And as the railway mileage of the United States is nearly equal to half of the total world's mileage, it is natural to assume that conclusions based upon our own experience would indicate general results and tendencies elsewhere. In 1860 the railways of the United States aggregated 30,630 miles in length, as compared with an aggregate of 179,280 miles on Jan. 1, 1895. This is an increase of 148,650 miles in 34 years, or more than twice the total world's mileage in 1860. In the fifteen years between 1880 and 1894, inclusive, the mileage of railways in the United States increased 93,726 miles, an average of 6,248 miles per annum; and in the first five years of this period the net increase was 40,759 miles, or an average of 8,152 miles per year. The effect of this rapid extension of carrying capacity can best be indicated by comparing rates and tonnage for certain intervals, and for this purpose the following figures for 1882 and 1894 are taken from the last issue of Poor's "Manual:" In 1882, the 114,461 miles of railways then in operation moved 360,490,375 tons of freight, with a tonnage mileage of 39,302,209,249 miles, and earned $485,778,341 for this service; equivalent to an average of 1.236 cts. per ton-mile. In 1894, 179,280 miles of railway moved 675,129,747 tons, with a tonnage mileage of 82,289,400,498 miles, and received for this work $700,477,409, or an average of 0.851 cts. per ton-mile. In the thirteen years, 1882-94, the total freight movement of all the railways of the country reached the enormous aggregate of 843,365,482,911 tons, and for this service the railway companies received $7,856,765,284. But had the average rate of 1882 prevailed throughout this whole period the public of the United States would have paid, in excess of the above amount actually charged by the transportation companies, a further sum of $2,567,232,085, averaging nearly $200,000,000 per annum. Whether this material reduction in rates in thirteen years be ascribed to more economical administration, to the increase in the volume of freight, to the attempt to secure traffic by cutting rates, or to any other cause, the gain to the public is evident enough. But it may be broadly stated that the growth of facilities for handling and transporting goods, joined to an intelligent economy in operation, tends to increase the volume of freight moved and to decrease the average charges upon this traffic. As an apt illustration of what modern appliances and conveniences for handling certain classes of goods will do in this direction, we have the cost of mining and shipping iron ore from some of the Lake Superior mines. Ore from the Mesaba mine is placed upon the cars at the mine at a cost of 20 cts. per ton, not including a royalty of 25 cts. per ton; but with this initial cost of 45 cts. at the mine it is transported over nearly 100 miles of railway, transferred to a steamer and taken over 780 miles of lake route to Cleveland, O., and there landed upon a dock for $2.25 per ton, every charge included. The average ton-mile rate on the railway was about 0.95 cts. in 1894; but the lake-rate, at 85 cts. for nearly 800 miles of transportation is but little more than one-ninth of the railway rate per ton.

Alongside the railways and under the seas is the electric telegraph, another strong factor in extending trade throughout the world by providing a means of quick communication. Of its social and political importance in furnishing us with the world's news of the day, mention has already been made, but who can measure its value from a commercial standpoint? In the slow-going days of sailing ships and stage-wagons all communication was by letter, subject to the accidents and delays that these means of conveyance imply. Business was conducted in a more leisurely way a generation ago, and months might elapse between the sending of an order and its execution in some distant part of the globe. With the telegraph and the telephone in every counting-house, the whole method of transacting business has altered. Space is no longer a bar and the element of time has almost disappeared in the transmission of advice or orders.

Statistics of the extension of the telegraph throughout the world, between 1860 and the present time, are not available; but they are not needed to impress upon the reader the wonderful importance of this agent in the sending of news. But for the telephone, much more recently introduced, it may be said that there are now over 200,000 miles of wire in operation in the United States alone, and in 1893 175,000 subscribers had over 500,000,000 "talks" with each other. Ten submarine cables connect Europe with North America, under the Atlantic Ocean, and another cable ties Brazil to Spain and the rest of the Old World. Other cables traverse the North Sea and bounding the western coast of Europe, pass through the Mediterranean on to India and the Far East.

Up to this point all that has been said refers mainly to the increased facilities for transport and communication on land; but the change in conditions for moving freight over the seas has been equally great and has had an even more important bearing upon the trade between nations. In the last 30 years the total carrying power of the shipping of the world, steam and sails, has increased from 13,770,000 tons to about 49,000,000 tons; and while the sail tonnage has gained over 1,000,000 tons in this period the chief growth has been in the steam tonnage, which was 764,000 tons in 1860, 7,400,000 tons in 1886, and is doubtless considerably over 8,000,000 tons at the present date. Between 1885 and 1895, 1,500,000 tons have been added to the displacement tonnage of the merchant marine of the leading commercial nations; a gain of over 9 per cent. in ten years. This rapid increase in steam tonnage has been the direct result of the cheapening of production by new processes in metallurgy and of the wonderful late development in the design and power of marine engines, with a corresponding economy in fuel consumption and general operation. The nominal horse-power of the engines of the "Great Eastern," launched in 1859, was 2,600, and this engine-power must now be contrasted with the 31,000 I. HP. of the "Campania." Ships of 8,000 tons and more are built to carry freight alone; and these vessels now swarm in every sea, with the natural result that the struggle for cargo and the general cheapening of the cost of transport has reduced freight rates to an unprecedentedly low figure.

With these improved facilities for the interchange of goods it is not remarkable that international trade has more than doubled within about 30 years. Mulhall, in his "Statistical Dictionary," places the approximate value of the combined imports and exports of the world at $7,445,000,000 in 1860, and at $16,885,000,000 in 1889. This growth in the volume of foreign trade created a demand for shorter trade routes and has been productive of some of the world's most remarkable engineering feats. The building of the Suez Canal, opened in 1869, shortened the length of the sailing route between Europe and the East by double the length of a continent; and the construction of a similar cut-off through Central America has only been delayed. The Corinth, Baltic and other shorter ship canals have all been built within the three last decades and at some time or another within this time projects have been advanced for cutting through about every narrow strip of land that anywhere separates two navigable and important seas.

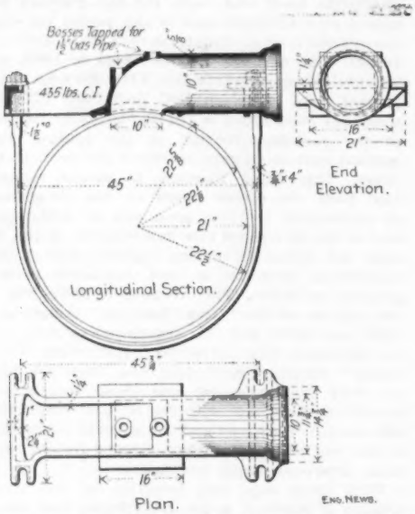
But enough has been said to plainly indicate that while the world's productive capacity, as measured by its gain in population, has normally increased in the last 30 years, the facilities for utilizing this capacity in manufactures and in supplying the world with the product of this labor have grown at an abnormal rate. As before remarked, this world of ours, measured by time and the cost of transport of men and goods from one part to another, is very much smaller than it appeared to be to our fathers. And the immediate effect of this shrinkage is a certain unity of interests throughout the globe and a sensitiveness to events commercial and financial outside of our own country, that never before existed, nor could exist under previous conditions. The wars of conquest and of personal ambition that so long occupied the time and expended the resources of nations, are giving way to industrial wars, within nations and between nations. And in the adjustment which is now going on everywhere the present scientific and engineering advance, which has alone made our material and commercial growth possible, must be well and duly considered.

LETTERS TO THE EDITOR.

Comments on Four Articles Published in Engineering News for Aug. 27.

Sir: There probably has never been an issue of Engineering News that had so many items in it upon which I felt that I could throw additional light as the one for Aug. 27. The first item that attracted my attention was a "Peculiar Break in a Water Main." In "The Technic," published by the Engineering Society of the University of Michigan, 1890, I described a similar occurrence at Greenville, Mich., the article being copied by your issue of Aug. 23, 1890.

The split sleeve described by Mr. Hill has been used in the Detroit Water-Works for nearly 20 years, it having been introduced here by Mr. Henry Bridge, Superintendent of Extension, about 1876. The Smith tapping machine



Saddle for Tapping Water Mains Under Pressure Used at Detroit.

has also been used by us for a number of years, and very satisfactorily, except in the matter of expense. On this account we are now experimenting with a machine of local invention, known as the Howe tapping machine. One of the advantages of the latter is that it is arranged for using any standard gate instead of a special form. It also takes up less room in operation, which is a considerable advantage in streets which are paved and must be resurfaced at a contractor's price per square yard.

We have also used here another device, known as a saddle, for tapping mains under pressure, of which I send you a print. The scheme of operation was to fit the saddle to the pipe and mark out the size of the opening, usually 10 ins. square. This was then cut out by drilling small holes, about 7-16-in., around the edge, being careful to drill them tangent to each other or with intersecting circumferences. As soon as the drill, which was wrapped with a cloth, was withdrawn a pine plug was driven into the hole. The swelling of these plugs was found amply sufficient to hold the piece in place after all the iron had been cut away, when working against 40 lbs. pressure. After the piece to be removed was entirely severed from the body of the pipe the saddle was put on and fastened in place by wrought-iron bands coated with graphite paint. The joint between the saddle and pipe was calked with lead and the connection made to the side line from which the pressure was let on and the apparatus tested. When all joints were found tight a steel bar was inserted through a short gas pipe nipple in one of the holes in the saddle directly over the opening. Two or three blows were given the bar with a light sledge and the piece cut out was knocked loose from the wedges and dropped into the pipe while the bar itself was driven out by the pressure of water. A wooden plug was immediately inserted in the nipple, driven tight and cut off flush with the top, after which the cap was screwed on and the connection was complete. As the saddle was already full of water from the side line when the piece was driven in there was no danger of rupture from shock. There were about 25 10 and 6-in. connections made in this way during 1893 and 1894, on 42 and 30-in. pipe lines, all of which have been entirely successful, excepting one in which a heavy sledge was used which broke out a corner of the piece without loosening the whole. After that experience we put in two holes for driving and used a light sledge and were thus able to make a clean opening in every case. The cost of these connections was only about one-tenth that of the Smith sleeve and valve for material and the labor was so nearly the same that there appeared no advantage in either from that point. As a rough-and-ready device for those who cannot afford the more expensive machines it will be found quite satisfactory for connections on large mains. It will be at once seen that the saving in cost over the Smith connection will decrease with the size of main and below 20 ins. there would be little if any economy in it.

Commenting further on the items in your issue of Aug. 27 it occurs to me that the table showing metered and unmetered water consumption at Lexington may be misleading in that the metered consumers do not seem to be charged with their share of the leakage of mains and slip of pumps, if any. You readily see that before meters were introduced this was divided among all taps, but as each tap was metered it ceased to be charged with the source of loss, so that in 1895, 223 taps appear to be bearing the leakage that should be charged to the whole 1,323. As I have thus far failed to obtain any very reliable statistics on the loss in street mains and fixtures from leakage, I doubt if the amount can be satisfactorily determined by guess. While I am heartily in favor of meters I think that over ardent advocates sometimes claim too much for them.

The American patent held by the Joly Iron Works on their stair construction strikes me as being of rather doubtful value, as the U. S. Lighthouse Department has been using practically the same device in combination of wrought and cast iron for the past ten years at least.

Very truly yours, G. S. Williams,
Civil Engineer to the Board of Water Commissioners.
883 East Congress St., Detroit, Mich., Aug. 29, 1896.

The San Juan Route for the Nicaragua Ship Canal.

Sir: I notice in a recent number of your valuable paper an article with map by Mr. J. T. Ford advocating a new route for the Nicaragua Canal. He proposes to dam the San Juan River just below the mouth of the Serapiqui, and thus flood the valley of the San Juan and use it for the canal.

Mr. Ford has evidently not read my article in the "Railway Gazette," published several months ago, in reply to a somewhat similar suggestion from him. In that article I stated that while in charge of the canal work in Nicaragua I caused careful and exhaustive examinations to be made at this locality with this very object in view, and I found to my regret that it was utterly impracticable, as nothing but swamps existed in that vicinity, and no flanking hills or high land for a dam could be found, although the country was examined for three miles in every direction.

There is a high spur of the Cordilleras which comes to the river's edge on the north side at this point, but unfortunately there is nothing but swamp on the south side of the river. Yours truly,

J. Francis Le Baron, C. E.
(Late Engineer in charge Nicaragua Ship Canal.)
Jacksonville, Fla., Sept. 11, 1896.

Timber for Harbor Work.

Sir: I have recently been consulted by a Danish importer of American lumber as to the adaptability and superiority, if any, of red cypress to southern yellow pine, for a bathing establishment to be located in salt water, and which is proposed to be built by the city of Copenhagen in the near future. Not being posted on harbor work in this country, I beg to ask for your opinion in this matter, in order to direct the proper authorities in their selection of American lumber to this or other harbor work in Denmark. At present a North German pine is extensively used, and is protected against the attack of the teredo navalis by thin sheets of iron. Yours truly, O. E. M.

Elmira, N. Y., Sept. 5, 1896.

TIE-PLATES.*

In our issue of Sept. 3, we had occasion to call attention to the important place which the tie-plate is taking in railway track, as an aid to greater efficiency and economy, and it is a significant fact that reports on this appliance were read and discussed at the annual conventions of the American Society of Railroad Superintendents and the Roadmasters' Association of America last week, as noted in another column. We give below an abstract of each of these reports. It will be seen that there is a very strong and general opinion in favor of plates having ribs which embed themselves in the tie, and also a somewhat strong opinion in favor of a rib on the upper side of the plate, to take the thrust of the rail flange in order to reduce the wear or necking of the spike. It is only fair to say, however, that the flat-top plate, without a rib, is far more extensively used than the shoulder plate, and that many persons who have used the former find them quite satisfactory and question the advisability of paying the higher price for the shoulder plate. The two reports are substantially as follows, and some notes of the discussion thereon will be found in another column.

Report of the Committee on Roadway; American Society of Railroad Superintendents.

The committee, recognizing the vast number of subjects connected with the roadway department of a railway that are of interest to you all, has considered it best to select some one of them as the principal subject of its report, the small number of members composing the committee and their inability to confer with each other frequently, making it almost impossible for them to cope with more than one of these subjects at a time. The subject of tie-plates is of particular importance to all who are concerned in maintenance of way, and we have made an effort to obtain such information as we can as to what the experience with them has been up to this time, in order to form an idea of what may be expected of them in the future.

You are all, doubtless, so familiar with the various designs of tie-plates that have been and are now on the market, that a detailed description of each can hardly be necessary. The conflicting claims of the manufacturers of each kind of plate, based on arguments that are at first glance so apparently sound, as well as the remarkable difference in the action of the same kind of plates under different circumstances, make it extremely difficult for any of us at this time to determine which form of plate is best for our particular use; and as it takes from five to ten years' experience to determine what good they will do our ties in the way of preserving them, or preventing their wear, a positive conclusion as to what form of tie-plate is the best can only be arrived at some years hence by the lesson of "the survival of the fittest."

One gentleman has stated, in his reply to the inquiries of the committee, that "the relation of the elements composing substructure, superstructure, motive power and character of traffic is so complex that any one kind of plate can not possibly prove satisfactory under all conditions"—and this is possibly true.

The requirements of a tie-plate are, primarily, the preservation of the cross tie, a point on which any argument is superfluous; and the importance of tie-plates as a factor in their preservation and the formation of good track by restricting rail movements is well established. The growing tendency to higher speed of trains and heavier rolling stock is rapidly making the task of maintaining a proper kind of track more difficult and more expensive; and the rapid depletion of our forests by the unceasing and increasing demand for railway ties, more especially hardwoods, and particularly oak, the high price of which in many sections of the country makes it no longer an economical tie to use, makes it necessary that this wood shall sooner or later be replaced by ties made of softer woods, either treated by chemical process to prevent decay, or by mechanical means to protect them from destruction by the mechanical action of the rail; and the tie-plate is, so far, the best means that has been devised toward the accomplishment of the latter result.

The several different designs of tie-plates that have been used in this country are more or less familiar to you all, such as the "Servis," the "Goldie," the "C. A. C.," the "Wolhaupter," etc. These have also been used to some considerable extent in Canada and Mexico, but information is lacking as to the forms of plates used in other foreign countries. An effort has been made to ascertain as far as possible what form of plate is best adapted to American railways, regardless of any particular form now in use, whether or not all of the elements necessary to the desired results are embodied in one plate, or form a part of the composition of many. The qualities necessary in a tie-plate to fulfil the service it is called on to perform may be generally stated as follows:

1. Adhesion to the tie, so that it can be considered as practically a part of it, preventing damage to the wood fiber and rattling by passing trains

2. Adhesion to the tie to prevent its lateral movement, even on curves of high degree, so that the track can not spread.

3. The above vertical and horizontal adhesion to be obtained by such a mode that it will not assist decay of the tie.

4. It should be so constructed that its application be simple and economical.

5. Its cost should be sufficiently low, so that, when added to the total cost of the tie in place, it will by sufficiently prolonging the life of the tie, pay for itself, due allowance being made for a saving in labor on track repairs, and a better condition of track.

The fulfillment of these requirements should have the following results:

1. Prevent damage to the tie by the rail cutting into it;

2. Make the use of rail braces unnecessary;

3. Make possible the use of soft wood and longer lived ties on curves as well as on tangents, and on all conditions of track;

4. Make possible the use of a tie in the track during its natural life under the most trying conditions of alinement, grade and traffic;

5. Greatly reduce the expense of maintenance of track to proper line and surface;

6. Make possible the maintenance of track in a safer condition, and afford relief to our forests of tie producing timber.

As to how these results may finally be obtained, investigation shows that enough experience has not been accumulated on which to form a decided opinion. A circular was sent to each member of the society, and also to a number of officials of roadway and engineering departments of large systems, who are not members of the society, to all of whom we are indebted for the careful manner in which they have answered our questions. The replies are in such varied form that it is not possible within the limits of this report to give them in detail, but we have selected from them such information, and have quoted the accounts of such experiences as we believe will be of most interest.

The total number of replies received was 73, in which 24 stated that they had not used tie-plates, and were therefore unable to express any opinion at all, and 49 had used them to a greater or less extent.

The number of tie-plates of each kind in use was not in all cases given, and we have no accurate figures as to how many there are. Several large systems of this country and some foreign roads using tie-plates have not been heard from. Only four systems that we have learned of have adopted tie-plates for use on their entire lines, one western road having nearly 3,000,000 Servis plates in use, principally on California redwood ties, also on cedar and some burnettized pine and fir. Another has 250,000 Servis plates on cedar ties, and another 293,000 Servis plates on California redwood, each of these systems having had them in use extensively from two to six years, while the total experience extends over various periods of from seven to ten years. A system in Massachusetts has had 300 miles of road equipped with plates for six years, the number in use being divided between the Servis, C. A. C., and Goldie, about equally. Valuable information was received from one southern line that has had 40,000 plates in use for four years, consisting principally of Servis and Goldie, with a few Wolhaupter, the kind of ties used not being stated, but presumably oak.

Accounts were given of the use of 300,000 Servis plates during the past eighteen months on another prominent southern road, and of some extensive experiments with Goldie and Servis plates on one of the northwestern trunk lines, but the majority of those replying to the circular report experiments with all of the different makes; more or less, without showing how many of each kind are in use. As a matter of information, it may be well to state that, where the number of plates in use was specifically stated, the aggregate number of each kind was as follows: Servis 4,565,000, Goldie 1,000,000, C. A. C. 600,000; however, these figures are of uncertain value, for the reason that they do not represent all of the tie-plates in use; yet they indicate a more general use of the form having longitudinal ribs entering the tie parallel with the grain.

So many different dimensions of plates of each kind are in use that it is well that attention should be called to them:

Servis.	Ins.			Servis.	Ins.		
2 ribs.....	3¾	× 8	× ¼	2 ribs.....	4	× 8	× ¼
2 ribs.....	5	× 8	× ¼	3 ribs.....	5	× 7⅞	× ¼
3 ribs.....	5	× 8	× 3-16	3 ribs.....	5	× 8	× ¼
3 ribs.....	5	× 8	× ⅜	3 ribs.....	5	× 8½	× ¼
3 ribs.....	5	× 8⅝	× ⅜	3 ribs.....	5	× 9	× ¼
3 ribs.....	6	× 8	× ¼	4 ribs.....	5	× 8	× 3-16
4 ribs.....	5	× 8	× ¼	4 ribs.....	5	× 8⅝	× ¼
4 ribs.....	6	× 8	× 3-16	4 ribs.....	6	× 8	× ¼
4 ribs.....	6	× 9	× ¼				
Goldie.				Goldie.			
4 ribs.....	5	× 6	× ¼	4 ribs.....	5	× 6	× ⅜
4 ribs.....	5	× 8	× 5-16	4 ribs.....	6	× 8	× 5-16
Goldie.				C.A.C.			
4 ribs.....	8	× 8½	× ⅜	4 ribs.....	6½	× 9	× ¼

The plates used at joints are generally punched, where necessary, to use spike slotting in splices, and the length of plate is frequently changed to conform to the additional width of the angle bar, although in a number of cases the same plate is used at joints as on intermediate ties. The kind of wood from which the cross-ties are made, the dimension of same, the weight of rail and width of its base, the volume of traffic and character of roadbed all enter into the question of determining what the dimensions of the tie-plate should be. As to the proper thickness of the plate, this question is one that must be determined by experience, although some very decided opinions have already been formed by officials that deserve the highest consideration; for instance, the chief engineer of one line declares that, "only a re-enforced thin plate will perfect a union with a tie, which union is essential to the usefulness of a plate. The vibrations of a heavy plate are sufficient in themselves to loosen them from the tie," while there comes from the manufacturers of a heavy plate (having lugs underneath cutting the grain of wood at right angles) the following argument against such a plate.

"There is not enough stock in this style of plate to stand corrosion and wear, and oppose the crowding of rail with the necessary resistance, for at least 25 years," the inference being that the heavier plate is expected to last that long in service. The latter statement is re-enforced by that of a prominent chief engineer of a system that has been experimenting for the past eight years with a number of different kinds of plates, that, "when made of heavy enough material (⅝-in. thick), the results were good. Where less than ⅝-in. thick, the tie-plates buckled. * * * All these forms of plates were used on steep grades and sharp curves, on heavy drill tracks in yards, and on bridges with sharp curves."

The same gentleman also advanced the following opinion:

"A tie-plate, to give good results, should have a thickness of at least ⅝-in., should have a shoulder on outside of rail, and should have sharp flanges or lugs to cut into the tie at right angle to the grain without tearing the fiber of the wood. Thin Servis plates have been worn entirely through from rust and friction within three years, and have been buckled in yards under heavy traffic in three months. Plates with no outside shoulder, made of thin metal, also have the objection of cutting into the back of spike heads on sharp curves."

And yet there are quoted below accounts of experiences from which opinions are given in direct opposition to those expressed above:

"The Servis 3-ribbed plates were placed on ties in M—— tunnel and were in service 3½ years and were completely worn out, in many cases only the ribs remaining, and these so firmly imbedded in the ties that it was almost impossible to remove them. The test of these plates was severe, as in addition to the wear from traffic, they were subject to corrosion due to gas and water. If used outside of the tunnel they would probably have lasted five or six years."

"We have an example of the use of Servis plates at G—— three years. They were put down on the inside of a 10° curve to prevent the rail from rolling over. These ties are now in condition to give three years more service, while the adjoining ties, which were new when the plates were put down, are in such a condition that they will have to be removed this season. * * * We have used Servis tie-plates as above mentioned, and have now adopted Goldie plates as our standard, size 7 × 6 × ⅜ ins. These are known as shoulder plates."

"A section of track 2,500 ft. long, which is a combination of sharp curves and tangents (a loop track whose alinements were confined by existing improvements, mansions, etc.) where we had from four to five men constantly employed gaging and surfacing without any satisfactory results, but since the tie-plates are in use, the track does not require any more attention than other sections. We have also reduced our track force at the rate of about one-half man per mile, but attribute this as much to the more settled condition of the roadbed after five years' running than to the use of tie-plates exclusively. We are saving in the cost of ties by making worn ties do their work by the aid of tie-plates. We save in the retamping of ties, otherwise consequent to changing of ties, which naturally always destroys the tamping. * * * It was the unsatisfactory work of rail braces on sharp loop track curves which prompted us to use the combination tie-plate." In this case, the Servis plate is referred to.)

"Plates were put on bridge ties. * * * Ties that were put in lasted for two years. New ties put in (where ties before lasted two years) were protected with tie-plates and have been in five years, and are in good condition. Ties (that previously lasted four years) when renewed were protected with plates, and now show no perceptible signs of wear after three years' service. * * * Servis plates on oak ties maintain a perfect union with the tie; on cedar ties, they do not under a light rail with heavy traffic, but do so under a heavy rail. The Fox plates break between the slots, and the parallel flanges under the rail shear off. The C. A. C. plates rattle. The Wolhaupter, I can not say anything in regard to, as we have just placed them in the track."

"200,990 were placed on California redwood in 1889, and ties of same wood and in similar soil have had to be removed on account of rail cutting into tie to such an extent as to cause breakage. The life of a redwood tie, without plate, is about six years; tie plates will more than double the life of such ties.

"90,020 have been placed on pine ties, and we figure that it increases the life of such ties 30%, saving in regaging curves in track work, which heretofore has been necessary once a year, thus spike-killing the tie."

"We have found that on curves, our chestnut ties lasted from two to five years longer where we have used plates, but we note the greatest saving where we have used them in the leads of our busy yards. In one yard in particular where we were obliged on account of the heavy traffic to renew the switch timbers every two or three years, when rebuilding this yard four years ago, we used tie-plates, and as yet the timbers do not show any perceptible wear. * * * We first used the Servis tie-plate, but are now using the Goldie principally, size 5 × 8⅝ × ⅜ ins., and 5 × 7⅝ × ⅜ ins. We have favorable results from both longitudinal ribs and with lugs cutting the grain at right angles, having adopted the Goldie in preference to the Servis on account of the shoulder and thicker plate that we are able to secure."

The engineer of maintenance of way of a line having used both forms of plates extensively, writes as follows:

We have never found either the Goldie claw plate or Servis rib plate loosening from the tie; that is, the union has always seemed to be perfect. While I think the bottom of the longitudinal ribbed plate is better than the Goldie, the shoulder is of greater value, and for this reason prefer the Goldie plate. We find that the lighter the rail the greater the proportional value of the plate. I think that some time there will be a plate made that will combine the longitudinal rib and the shoulder on full width of the plate. This, I think, will be accepted as the standard plate when made.

(The above is from an official of a road that uses cedar ties exclusively.)

The following is from a letter from the engineer of maintenance of way on a different portion of the same system, on which cedar and burnettized hemlock ties are used:

"Our objection to the Servis plate was that we found that they did not adhere to the tie under all conditions. This was demonstrated by some of the plates on a few curves put in during the previous four years. We found that the plates had moved in the grain of the wood as much as half an inch, spikes and all moving with them. Thus far, we have found the plate with lugs or claws all right, but as our experience with the latter has not been for more than a year, we are not satisfied as to what the result may be after several years' service."

It is possible that in the last case referred to, the ties were of such soft wood, and the other conditions were such, that they would not act well under any circumstances; however, this is merely a surmise.

It is observed that where a very positive preference is expressed for a particular kind of plate, it is often the case that no experience has been had with any other form, which is a good argument for tie-plates in general, but not a strong one for the superiority of one form of plate over the other. There are some notable exceptions, however, where, after having made extensive experiments with several kinds of plates, one particular form has been finally adopted. These cases are deserving of the most serious consideration.

By far the most important feature of a tie-plate is the means by which its contact with the cross-tie is maintained, and, naturally, on account of the different means employed in the various makes of plates, there is more diversity of opinion as to this feature than any other.

The question is mainly, whether the union of the plate with the tie shall be secured by ribs entering the tie parallel with the grain, or by lugs or claws entering the tie at right angles to the grain. Of the 44 opinions received on this point, 28 declare their unqualified preference for the plate with longitudinal ribs, 8 are equally as positive in their preference for the other form, 3 appear to be as well satisfied with one as the other, and 5 have not yet formed a positive opinion either way.

Some of the principal arguments advanced in favor of a plate with longitudinal ribs are as follows: It adds materially to the stiffness of the plate; it excludes water, etc., from between the tie and the plate because of a closer adhesion; it does not weaken the tie by cutting the fiber; it is more easily adjusted. Some of these opinions are quoted in full as follows:

The track can be re-arranged better and at less cost with plates with longitudinal ribs than with plates which cut the fiber at right angles.

Where the ribs enter the wood parallel with the grain, they simply push the fiber to one side in entering. The fibers immediately begin to close up around the ribs, and in a short time, the iron ribs and the fibers of the wood adhere so closely that the plate can not be pulled out of the tie without bringing some of the wood fibers with it. On the other hand, any projection entering the wood across the grain cuts the fibers, leaving a gaping hole which never closes up, and the plate can always be easily removed from the tie, and in fact, is apt to be loose and to rattle at any time. This can be very simply and clearly shown by an axe. If a sharp axe is driven into the tie across the grain to the depth of one inch and left there, it will be very apt to fall out of itself in a short time, but if it is driven to the same depth parallel with the grain and left there for a day or two, it will be hard to pull out.

1. The ribs entering the tie do not cut the fibers, but simply compress them, and these compressed fibers are continually re-acting on the ribs, thus holding the plate firm.

2. The weight of trains on these does not tend to elongate the fibers, but to spread them laterally. This increases the pressure of the wood against the longitudinal ribs, and keeps the plate and tie permanently bound together.

3. When the tie begins to decay (when a plate is of most service), the longitudinal flanges hold the soft fibers of the wood together, thus prolonging the usefulness of the tie.

4. The longitudinal flanges give a better distribution of a given amount of metal for strength, and allow plates to be made thin enough for elasticity.

On the other hand, one superintendent expressed the belief that the tendency of the longitudinal ribs is to split the tie, but this theory is not supported by any argument that we have seen. It is claimed by those who prefer the tie-plate with lugs or claws cutting the fiber at right angles that they are more easily applied than the other kind; and it may be noted that this same claim has been made for both forms. One writes in regard to the Goldie plate as follows: "This form is best for the reason that lugs across the grain hold the plate tight to the tie, and offer more resistance to the movement of the plate, and do not tend to split the tie as does the ribbed plate parallel with the grain," while the following arguments have been received against any form of plate having lugs that cut the fiber at right angles:

Every pressure of the plate would have a tendency to compress the fiber of the tie, and thus cause a larger

space in which the lug could work, resulting in a loose plate.

They are decidedly not suited to the softer woods.

The object of a tie-plate is to prevent the rail cutting across the fiber, or in reality to prevent what a plate with lugs actually does.

It is not desirable, such plates without stiffening ribs have to be much thicker and therefore heavier and more expensive in order to give satisfactory results. We do not think a plate with lugs cutting the grain at right angles will adhere as well as the other.

I have noticed that where lugs are used, the plate is apt to bend so that the lugs at one end of it only enter the tie, and the result, of course, is unsatisfactory.

A claim of the makers of the C. A. C. plate is that "the re-enforced lugs directly under the center of rail-seat insure quick penetration into the wood, and as they do not come to the edge of the plate, but are covered on all sides by a good margin of metal, no water can get in to soften the fibers of ties, loosening the hold of the lugs. Lugs thus interiorly placed are not only more effective, but lessen the tendency of the plate to sag in the middle, as in the case of that form of plate with lugs bent down at edge of plate, or at corners."

As to whether or not a tie-plate should have a shoulder on the outside of rail to relieve the spiking, and assist in maintaining the gage, it seems to be the general opinion that such a shoulder is desirable, although a large number of engineers and other officials who have used plates with no shoulders are of the opinion that it is unnecessary. It does seem, other things being equal, that a plate with a shoulder on the outside of rail, and especially one with a shoulder extending entirely across the plate, would do more toward keeping the track in gage and lessening the wear on spikes than one without such a shoulder, and that a plate so constructed would be of particular benefit on curves. The statement is made by some that a plate without a shoulder at all is not a complete rail brace, "as the fibers of the tie are too soft to offer sufficient resistance to the spreading of gage;" however, this opinion may have been expressed with only a view of using ties made of soft wood. Only a few superintendents claim that rail braces cannot be entirely dispensed with on sharp curves, while it is the most general opinion, so far as we are able to learn, that tie-plates fully perform the functions of a rail brace, and are in fact an improvement on them. For instance, one states that "they are very effective in preserving gage and saving spiking on account of ribs (uses the Servis combination plate) entering the tie and furnishing sufficient resistance so that the track in which we have laid four consecutive ties with plates without spiking on a 9° curve with a 5-in. elevation, the gage was perfectly preserved."

Another states that he "considers them better than braces, as the plate holds the rail perpendicular, and makes a more uniform surface wear, and so prevents scaling, prevents the rail spreading, which, with 60-ton engines on curves at fast speed, is not overcome by braces on every second tie on curves of 8° and over, and every third tie on curves of less than 8°." A very clear explanation of the action of a rail brace, as well as a good argument in favor of tie-plates was given us by Mr. J. A. Dodson, of the Southern Ry., as follows:

The centrifugal force exerts a strong pressure on the head of the rail, tending to revolve it about the outer edge of its base. This unequal bearing of the rail on the tie, combined with the sawing or abrasion of the tie from the rail flexure as each wheel passes over, soon depresses the outer edge of the rail into the tie, thus destroying its vertical position. This is a tendency which may be retarded, but cannot be counteracted by a rail brace; a rail cannot turn over until the outside of base is lower than the inside. When the tie becomes cut at the outer edge of rail base, the brace is forced into the tie at its edge nearest the rail and slightly draws the spike at the side remote from the rail. When such a condition is reached, which does not require any considerable length of time, the flange of each wheel begins to shave the head of the rail on the gage side, which is destructive to both rail and rolling stock. The only remedy is to draw all the spikes, adze the tie and prepare for a repetition of the same trouble. By using tie-plates, the cutting of the tie is stopped, the rail is maintained in an upright position to gage, and all trouble from this source vanishes. The saving in ties, rail, wheels, spikes and labor is considerable, sufficient to pay for the tie-plate several times.

As to the effect on spiking, there appears to us to be reasons why a plate with a shoulder should be more beneficial than one without it, provided the plate is so constructed that the only function of the spikes that is left is that of holding the rail down to the ties. There can be no doubt, however, that any of the plates in question, either with or without a shoulder, will have a beneficial effect on the spiking, as the punched holes of the tie-plate insure the spikes being driven vertically, for men will naturally exercise more care in starting and driving them; first, because the plates require it, and second, because improper spiking is more easily detected if the spikes are not driven vertically, and any attempt to straighten the spikes by hitting them with a maul will only make matters worse. The spike holes, however, should be of such a size and position that the spikes shall fit the rail flange snugly in order that the spike heads shall have the proper hold on the rail. On some roads where plates having no shoulders are used, three spike-holes are punched so that two spikes can be used on the outside of rail, with very satisfactory results as to keeping the track to gage. No considerable use seems to have been made of plates of a bevel or wedge-shaped form, but some manufacturers have recommended them "to give the rail an inward inclination and at the same time increase the thickness of the plate at the shoulder, thereby increasing its stability, and reduce the flange-wear of the rail heads."

One official reports having used such plates, but says that they are at present using the Servis plate both on curves and tangents, considering it for all purposes as good as the wedge-shaped plate. One or two members have recommended a plate with a bevel of from 1-16 to ⅛-in.

A very few objections have been received against the use of tie-plates on heavy grades, the possibility of bad results being suggested from the "reducing of friction contributing to the rail running down hill." One suggests that "if spikes are allowed to raise up, the rail would creep more readily on a steel plate than on wood, and where the force is small, spikes will work up," but it is not probable that there is much foundation for such an objection.

As before stated, it may properly be said that all of the different forms of plates mentioned above have their good points, but it would not be safe at this time, considering the comparatively short experience that has been had with them, to condemn or to approve of either kind. It is possible, as was before suggested, that no one form of plate yet devised will give perfect results under all conditions, yet it appears that a plate combining longitudinal flanges entering the tie parallel with the grain and a shoulder on the outside of the rail, would be most desirable. That tie-plates, as one of the most important features of track equipment, have come to stay, there is no doubt; and that they are of special value on sharp curves and heavy grades; in tunnels, particularly where wet and where the difficulty of securing good track is great because of the softening of the ties by the action of water, gases, etc.; in yards where there is constant switching and heavy traffic; at platforms in front of stations; and in street crossings where the ties are kept soft by moisture, and where it is both difficult and expensive to get at the track for renewal of ties, re-surfacing or re-gaging; on bridges and trestles, particularly those on curves, and on grades where a great deal of sand is used and where traffic is very heavy. It is possible that in the southern states where oak ties are plentiful and cheap, their use on tangents might not be justifiable, but in the north and west where only soft ties are to be had, or where the price of ties is high, their general use on all kinds of track seems desirable.

The following extract from a very interesting communication from the chief engineer of one of our most important railways is worthy of consideration: "There are, I believe, very few roadmasters who, if they were asked to choose, for general use, between 60-lb. rail with tie-plates and 75-lb. rail without tie-plates, would not select the latter. The cost is about equal."

We have not attempted to go very deeply into the question of the cost of tie-plates, being more particular to consider their mechanical features. Their cost, of course, largely depends on their weight and dimensions and the number used, ranging from 5 to 15 cts. each; but we think it would be more proper for those desiring information of that kind, to obtain it from the manufacturers themselves.

Report of the Committee on Tie-Plates; Roadmasters' Association of America.

The committee communicated with the various manufacturers requesting they be furnished with a sample of their appliance. The Q. & C. Co., of New York and Chicago, furnished the Servis plate; the Railroad Supply Co., of Chicago, the Wolhaupter plate; the Avery Stamping Co., of Cleveland, O., the Fox plate, and Dilworth, Porter & Co., of Pittsburg, the Goldie plate. These plates were taken and imbedded by a hydraulic machine in a new yellow pine tie.

1. Tie-plates certainly hold rail to gage.

2. They prolong the life of soft wood ties from mechanical decay or wear five or six years, and hard wood ties two to four years.

3. They are invaluable on curves.

4. A spike has a better support when used with the tie-plate than without, as the tie-plate gives the spike a required backing.

Practical experience has shown that any form of tie-plate to be successful must unite itself to and become part of the tie. Designs of tie-plates which fail in this particular feature have invariably proved unsuccessful. Most of the tie-plates offered cover this feature, but some of those on the market fail entirely in this regard, and your committee is unable to see where they are of any practical service.

There are three factors working in conjunction with the tie-plate: the tie, the rail and the spike.

In the rail, the wave action causes an alternate rise and drop to a bearing on the tie-plates and thence to the ties; this results in a jumping movement of loose tie-plates if the imbedment is not firm and thorough. This loosening indents the ties, breaking or bending the tie-plates and causing a lamination of the rails. Where the tie-plate fails in the imbedment and causes the above results the remedy adopted by the manufacturers seems to have been to increase the thickness of the plate, which does not prevent the undulation of the rails but adds a heavier plate, and while the tie-plates are saved, the rail receives increased wear, spotting and spalling the rails. In an experimental test made by the Pennsylvania R. R. in 1870 of a flat plate 6 ins. square and ⅝-in. thick, they acted as an anvil and caused the rail head to show a spot where the wheel struck it immediately over the tie-plate. These plates were not imbedded in the tie and possessed none of the mechanical qualities for imbedment of any of the tie-plates now on the market.* About 1880 the Manhattan Ry. had a similar experience with a flat plate and was obliged to take them out of the track. In fact it had decided to use no tie-plates until those allowing the flange for imbedment came upon the market. It is obvious that any tie-plate that has not a good firm and secure imbedment in timber, is useless.

Any and every tie-plate should be heavy enough to act as a perfect bearing plate under the rail, but where increased thickness is used either the tie or the rail has to suffer. When tie-plates unite themselves to the ties a much thinner plate can be and is used; for such plates partake of the stiffness and strength of the wood which supports them, that is providing the plate has a full and good imbedment. Your committee finds in reports received that the wave motion of light section rail is much more severe than of the heavier rails, now being generally used, so that any tie-plate found resisting the action of the former has a reserve of strength and can be safely used with the latter. In connection with the matter of heavier rails, it is an error to suppose that the stiffer the rails the more severe the wear is on the tie-plate, or tie supporting them, as on some lines the number of ties used per rail length is reduced when the heavier rails are laid.

In looking over many cut ties it became evident that most of the wear is due to the moving rail and even in the softest woods where indentation was to be expected, there was but little appearance of it. It is here that the tie-plate proves of the greatest service. It prevents the tie from being cut into by lessening the up and down motion and decreases the lengthwise movement with the result that there is less creeping of rail and little or no wear into the tie, if the tie-plate is properly imbedded.

The duty of the spike is to prevent lateral motion of the rail. If imperfect spiking is done this is not accomplished, and to accomplish perfect spiking the tie-plate should have its holes so punched as to allow a close fit of the spike to the rail flange. Where this is not done trouble is experienced in the wear of the parts due to the working in and out of the rail against the spikes. This in connection with the up and down movement causes a wear in the neck of the spike. It is therefore most essential that tie-plates should be properly punched, and no tie-plate should be placed in position unless the tie has been adzed to a true bearing, as the principal cause of tie-plates buckling has arisen from this neglect, for no tie-plate can be a bridge. In connection with this last finding the committee has been struck with the fact that many of the tie-plate manufacturers are placing a shoulder on the plate, and that said shoulder as now used is of little or no value, for when the spike wears the rail gets loose motion and the shoulder and spike both cut. To the mind of your committee it appears if this shoulder were placed the full width of the tie-plate it would offer a support for and reduce the strain on the spike with consequent and better results in the line and gage of the rail.

While considering the three important essential parts which enter into the relation of the tie-plate, your committee fully understand that the tie itself is the principal factor, and have tried to secure information as to results obtained with different woods used with and without the tie-plate. The consensus of opinion seems to be that the life of the cedar tie averages 12 or 14 years, hemlock ties 5 years, tamarack ties 6 years, and oak ties 9 years. The price of ties is so variable in different sections of the country your committee find it hard to strike the average cost, yet in all the reports we have received the invariable answer has been that where the tie-plate has been used, no matter the quality of the tie, it has prolonged the life of the timber from mechanical wear. Furthermore, the committee finds that better results have been obtained from a narrow than a wide tie-plate, and feel that a plate 5 ins. wide is ample for all purposes.

On the second division of the subject matter: "Will the Use of Tie-Plates Dispense with the Use of Rail Braces?" your committee, after a most thorough and searching experiment and investigation, unhesitatingly state they will do so. We have received reports showing where they have proved successful on curves of 3° 30', 4° 25', 15°, and even on 60°, where they have held the rail in place without any rail braces being used. Moreover, no lateral movement or cutting of ties has occurred on these curves, and the track is in perfect and true gage.

Your committee has had reports from chief engineers and roadmasters in all sections of this country where ties have been used under almost all possible conditions with and without tie-plates, and the reports received show that the use of the tie-plate is a very necessary appliance on all track work.

*It should be stated, however, that the Pennsylvania R. R. still favors flat plates.—Ed.

Its use is economic, as it reduces the repairs on the road bed and makes a more perfect track with consequent reduction on repairs of rolling stock. Further, its use as a measure of safety is beyond question, for it means truer gage to the track. Your committee unite in recommending the general use on all repair and construction work of the tie-plate, and feel that its added cost to the track maintenance will be more than compensated by the cost of labor saved in tie renewals alone.

R. Black, Chairman; J. B. Moll, Geo. W. Light.

A TABLE GIVING THE PERIMETER, AREA AND HYDRAULIC MEAN RADIUS OF EGG-SHAPED SEWERS.

A handy table for use in designing egg-shaped sewers has been handed us by an engineer and is published herewith. The table is based on a sewer having a horizontal diameter of 1 ft. and a vertical diameter of 1½ ft., and gives the wetted perimeters, areas and hydraulic mean radii for such a sewer, with varying depths of flow up to two-thirds of the full depth of the sewer. To apply the table to other sizes follow the directions beneath the title to the table.

Table for Finding the Wetted Perimeter, Area and Hydraulic Mean Radius of Egg-Shaped Sewers Where the Horizontal Diameter is Two-Thirds the Vertical, and the Sewer Flows Not Over Two-Thirds Full.
(For corresponding values of p, a and r for other sewers of like proportions, $A = a \times D^2$; $P = p \times D$; $R = r \times D$; D being the horizontal diameter of the other sewer.)

d.	p.	a.	r.	d.	p.	a.	r.
0.100	0.464	0.0280	0.0604	0.270	0.870	0.1163	0.134
0.110	0.488	0.0312	0.064	0.275	0.882	0.1192	0.135
0.120	0.512	0.0364	0.071	0.290	0.915	0.1285	0.140
0.125	0.524	0.0387	0.074	0.300	0.938	0.1357	0.144
0.130	0.536	0.0404	0.075	0.325	0.992	0.1512	0.153
0.140	0.560	0.0449	0.080	0.350	1.048	0.1690	0.161
0.150	0.585	0.0495	0.085	0.395	1.101	0.1867	0.169
0.160	0.610	0.0548	0.090	0.400	1.159	0.2050	0.177
0.170	0.634	0.0597	0.094	0.425	1.215	0.2238	0.184
0.175	0.646	0.0625	0.097	0.450	1.268	0.2435	0.192
0.180	0.658	0.0646	0.098	0.475	1.321	0.2637	0.199
0.190	0.681	0.0695	0.102	0.500	1.375	0.2840	0.207
0.200	0.706	0.0748	0.106	0.550	1.480	0.3267	0.221
0.210	0.730	0.0803	0.110	0.600	1.584	0.3702	0.234
0.220	0.753	0.0858	0.114	0.650	1.687	0.4159	0.247
0.225	0.765	0.0884	0.116	0.700	1.790	0.4618	0.259
0.230	0.777	0.0917	0.118	0.800	1.994	0.5580	0.280
0.240	0.799	0.0976	0.122	0.900	2.194	0.6563	0.299
0.250	0.823	0.1036	0.126	1.000	2.392	0.7560	0.316
0.260	0.846	0.1096	0.130				

CONVENTION OF THE AMERICAN SOCIETY OF RAILROAD SUPERINTENDENTS.

The twenty-sixth meeting of this association was held at the International Hotel, Niagara Falls, N. Y., on Sept. 9 and 10. At the opening session on Sept. 9, with the President, Mr. Charles B. Price (All. Vall. R. R.) in the chair, the first business was the reading of the report of the Executive Committee. This report called attention to the new arrangement of the meetings, and to the desirability of enlarging the sphere of usefulness of the society. It recommended a larger number of committees, or a larger number of members on the present committees.

A proper and convenient classification of the committee work would, of course, require considerable study, but the general idea is to let the society's organization for work follow naturally that of the railways themselves, so far as the department coming under the immediate jurisdiction of superintending officers is concerned. It is further recommended that a number of cash prizes (say of $50 each) be offered, either by the committees or by the society, for papers or special reports on a variety of live topics connected with the operating and maintenance departments. These papers should be received early enough to permit of their being printed and distributed in advance of the meeting. In this connection, the committee suggests the propriety of collecting all papers and reports of importance which have appeared in the printed proceedings of the past 25 meetings and publishing the same in permanent form, carefully edited and well indexed, and with such revision as may seem desirable. Such a volume would be of great interest and value to every railway man in the country, and would undoubtedly command a sale sufficient at least to pay the cost of publication.

It may also be worth your consideration to look into the plan, originally proposed by your Secretary, of forming a closer affiliation with representative bodies of railway officials, such as master mechanics, car builders, roadmasters, accountants, etc., who, under the organization of most railway companies, report directly to the superintendent. Such a movement, however, could best be initiated by a meeting of the executive committees of each organization, to look over the ground and report to their respective bodies such recommendations, if any, as may seem to the best interest of all.

The report of the Treasurer, Mr. R. M. Sully, showed the following summary: Balance in hand in 1895, $1,311; receipts, $1,467; expenses, $1,408; balance in hand in 1896, $1,369. The report of the Secretary, Mr. C. A. Hammond, showed that the membership consists of 214 active members, 18 associate and 5 honorary; 5 members have resigned since the last meeting, while 3 have died. The total present membership is 237, a gain of 12 over those reported at the last meeting. Since the last meeting the Society has lost the following members by death: John Adams, General Superintendent, Fitchburg R. R.; Wm. G. Wattson, Division Superintendent, West Shore R. R., and Waterman Stone, honorary member, and the first secretary of the society. Pecuniarily there has been a falling off from last year, more than offset, however, by decreased expenses. Besides the regular reports and proceedings and the papers by members, the Society has within the last few years reviewed, and published in its proceedings, special papers, including the following: "The Improvement of Railway Track," by E. E. Russell Tratman; "Rails and Rail Fastenings," by J. Churchward; and "Roadway Department Economics," by Andrew Morrison.

The next business was the reading of the report of the Committee on Roadway, an abstract of which is given in another column. This report dealt mainly with the now very important question of the value of tie-plates, but concluded with the suggestion that the question of the merits of different processes of tie preservation and the experience with ties so preserved should be taken up by the committee for the next year. In the discussion, Mr. Derr (Erie R. R.) said that he had in use some hundreds of thousands of the Servis plates, and he advocated their use on every tie on curves and on alternate ties on tangents; he did not favor thick plates. Mr. Hammond thought thick plates advisable for yard tracks.

The report of the Committee on Machinery was then presented by Mr. Potter (Flint & P. Mar. R. R.). He explained that the committee believed that the general subject was fully taken up by the mechanical societies, and had therefore prepared a short report on the motive power of the future, referring to electric traction. An abstract of this is given below:

Electric Locomotives on Railways.

We have arrived at a very interesting point in the evolution of railway motive power, a point of transition from old methods and theories to new ones, a point from which it seems possible to almost certainly predict the entire change from steam to a more economical motive agent. Already the electric motor appears as a formidable competitor of the steam locomotive in suburban and interurban traffic in many parts of the country, and he who brings himself to believe that the application of electric power for transportation purposes will never get beyond this class of traffic has a very narrow vision of the field of progress. Unless we make the assumption that we have reached the end of progressive development, we must admit the very great probability of the entire suppression of steam by electricity as a motive power on our railways, not only in suburban and inter-urban traffic, but in cross-country traffic also.

Primarily, such change will take place because the perfection of economy has probably already been reached with regard to the application of steam. We have every reason to believe that the steam locomotive of the present day represents the perfection of economy in its peculiar field, or very nearly so, as there are no valid grounds for believing that the application of the principle of compounding will work much of a revolution in economical locomotive practice, and there seems no other direction in which to look with any degree of confidence for a further economical application of steam power.

There is a wide chasm between the actual and the theoretical economy of the steam locomotive, and it is a chasm which the highest talent of the entire civilized world has for many years been trying to bridge. The effort has resulted in the production of a wonderfully perfect mechanism, the modern locomotive. But in spite of its perfection, the modern locomotive is far from being an economical machine when judged by the standard of the theoretical, and the very fact of its perfection is the sign of its doom. There still remains this chasm to bridge, and there still remains the inventive faculty of mankind which is striving to bridge it.

As long as there was any possibility of improvement in the steam locomotive, man's inventive faculty concentrated itself there, and by every possible means endeavored to attain the theoretical point of economy with the aid of the agent, steam. But now the time is at hand when the limitations of steam have been fully recognized for all practical purposes. The limit has been reached. But the perfect application of steam still falls far short of the goal strived for; that is to say, the perfect machine is actuated by a force which has properties that do not admit of the highest economy. Man's inventive faculty, therefore, must turn to this new force which has properties that promise a greater economy in its application to motive power and strive to invent and perfect the machine which shall control and apply it. It seems just as certain that the perfect electric motor will be evolved from the present conditions as it is certain that the perfect steam motor has been evolved from the conditions which were present 50 years ago.

The first efforts to apply electricity are crude, just as the first efforts to apply steam were crude; the first electric motors are very imperfect, just as the first steam motors were very imperfect; but constant work on the problem will gradually evolve improvement after improvement, just as the steam motor was improved, until at last it has produced the mechanism which controls and applies the electric force to the full extent of its natural limitations. What those limitations are, we can only conjecture; they are no doubt much further in the future than the limitations of steam power were three-quarters of a century ago.

However, the almost certain knowledge that electricity will eventually supersede steam as a motive power on our railways need not disturb us in the least; it need cause not the slightest uneasiness to any existing interest, because it is absolutely certain that the supersession can only take place in conformity with well-defined laws of progress which must infallibly operate to adequate compensation for all apparent losses incurred during the period of transformation. It will merely represent a higher development of the means of transportation, and will have its analogy, so far as economic consequences to existing interests are concerned, in the change from the stage coach by the steam locomotive.

The 35,000 steam locomotives on our railways, representing a capital investment of at least $250,000,000, are not to be consigned to the scrap heap on an uncertainty, nor even in a hurry. Before the new power has the slightest chance to supersede the old, it must positively prove itself the economic superior of the old, and the demonstration of this economic superiority necessarily carries with it full compensation for all apparent losses that may be incurred.

We shall be compelled to meet these problems with our present resources as long as possible, and manipulate our present instruments for all they are worth, until their insufficiency has been absolutely demonstrated. When that time comes, there will be nothing left for us not to change to the new instruments and enter the field of competition on equal terms. It stands us in hand, then, to keep pace with the development in the science of electrical engineering, so as to be fully prepared to act intelligently on the changes that force themselves upon us, whenever it so happens that those changes are demonstrated to be unavoidable.

There was not much discussion on this, but what little was said appeared to indicate that a change from steam to electric traction was most probable but could not be a practical issue for very many years to come.

The report of the Committee on Transportation was read by Mr. Knibloe (Buff. Creek R. R.); it dealt mainly with the tonnage standard for loading freight trains, as a means of economy in freight service, and was substantially as follows:

Tonnage Rating of Freight Trains.

A circular was sent out containing interrogatories as to the methods of loading trains, whether by the tonnage system or by the car system. From over 200 members only 52 replies were received. Of the 52 roads represented, 22 were loading trains by the tonnage method, the balance were not. From the replies received from the members on whose road the tonnage system is in vogue, it is clearly shown that large savings can be made by use of the tonnage system. The percentage of increase shown in tons or cars per train by reason of the use of the tonnage system varies from 3% to 20%. The use of the tonnage system in five cases reported has served to increase the average speed of trains. In the other cases reported the speed has either decreased or no change has been noted. In a majority of answers it is shown that the tonnage system of loading trains gives greater uniformity of movement and avoidance of overloading of trains. Reports show that there is a large field for improvement in systematic effort tending to increase the number of tons of freight per car. One member reports that he has made an increase of from 12% to 15%, which is a remarkable showing. We therefore recommend that the tonnage system be used in loading trains in preference to the car system, and that the question of the loading of cars to full capacity is one that deserves close attention and will give very gratifying results.

In the discussion it was suggested that this was a case for the use of the dynamometer car to determine the actual efficiency. Mr. Brunn (Erie R. R.) said the tonnage system is giving excellent results on his road, one important result being that more empty cars are now available. Mr. Knibloe considered that additional track scales should be put in to facilitate the working of the tonnage system, while the length of trains should in any case be limited to that which the train crew can properly handle, regardless of loads.

In the afternoon there was an excursion to the power house of the Niagara Falls Power Co., after which another business meeting was held. At this meeting Mr. Derr (Erie R. R.) presented a very brief report from the Committee on Signaling, explaining that it had been thought preferable to invite some signal engineers to address the society. He therefore introduced Mr. Charles Hansel, Vice-President and General Manager of the National Switch & Signal Co., who delivered a most interesting address on the principles of signaling and interlocking, illustrated by an exhibt of the appliances used, and a complete set of instruments of the train-staff system of block working. In the explanation of the operation of these appliances he was assisted by Mr. Patenall, the inventor of the Patenall electro-mechanical slot. When Mr. Hansel had concluded his address, Mr. J. G. Schreuder, Chief Engineer of the Union Switch & Signal Co., exhibited a working model of an overlapping block signal system for single or double track lines, the signals being of the disk or "banjo" pattern. This system we shall describe and illustrate in another issue. The discussion was postponed until the following day, when Mr. Derr and Mr. Brunn explained the very complete system of absolute block working on the Erie R. R. Mr. Price (All. Vall. R. R.) has two yard sections fitted with the Union Switch & Signal Co.'s system above noted. Mr. Neville Priestly, of the Indian State Railways, said that on these railways there are signal and interlocking plants at the stations, but not to any extent on the open line, owing to the lightness of the traffic. We shall give a more complete report of this discussion in a later issue.

In the evening there was the annual banquet, which was a very enjoyable affair.

At the meeting on Sept. 10, the discussion on signaling was taken up, as already noted, after which there was a general discussion on the report of the special committee (presented at the meeting of 1895) on "The Relations Between Railways and Their Employees, Including Methods of Training and Discipline." In the afternoon there was an excursion down the Niagara Gorge Electric Ry. to Lewiston, on a special train, by invitation of Mr. J. M. Brinker, President of the railway. The party then crossed the river to Queenstown and returned on the Canadian side of the river by the Niagara Falls, River & Park Electric Ry.

CONVENTION OF THE ROADMASTERS' ASSOCIATION OF AMERICA.

The fourteenth annual convention was held at the Cataract House, Niagara Falls, N. Y., on Sept. 8, 9 and 10, with a fairly large number of members and guests in attendance, and an exceptionally large and comprehensive exhibit of track tools and appliances. The opening meeting was held Sept. 8, the President, Mr. C. E. Jones

(C., B & Q. R. R.) being in the chair, and the Vice-President, Mr. Kerwin (C. & N. W. Ry.), and the Secretary and Treasurer, Mr. J. B. Dickson (C. & N. W. Ry.) also present. The meeting was called to order at 11 a. m. Mr. Jones read a brief address, referring to the important work of the proper maintenance of the 180,000 miles of track in this country, and the proper handling of the army of men engaged in the work. The roadmaster should be able to instruct his subordinates in theory, and to lead and direct them in all practical work, especially in case of washouts, wrecks or other emergencies. He briefly referred to the aims of the association in bringing roadmasters in contact with each other, for the exchange of opinions and experiences, with the object of improving their efficiency and value to the railways. The association, he said, now has about 600 members.

Brief addresses were then made by some of the older members. Mr. Caffrey (L. V. R. R.) said that he never failed to get instruction at these meetings, and to go back with new interest and confidence in his work. He thought that the higher officers do not yet recognize the importance of the association and its work, and that it would be for the benefit of the railways if the officers insisted upon their men attending the conventions instead of merely giving them permission to attend when it is asked for. He also referred to the great increase in speed of trains which had been so noticeable within recent years, and which has in many cases been apparently made almost without consideration of the track conditions. Mr. Kerwin referred to the satisfactory condition of the finances of the association, and Mr. Collins made a few remarks as to the desirability of members present attending the meetings instead of sitting outside and discussing matters in a personal way. It may be noted here that there was very little interest shown in the discussions, though these are (or should be) the most important part of the proceedings. Perhaps if the reports were required to be sent in to the secretary in time to be distributed to the members a month or so before the meeting, the discussions might be more free, as the members would have had time to consider the reports.

The secretary, Mr. Dickson, then read his report for the year, showing the following results: Receipts for dues, fees and advertisements in the annual report, $1,941; expenses, $1,325; balance in bank, $615; amount still due to the association in payment for advertisements, $225. A vote of thanks was tendered to Mr. Dickson for the efficient manner in which he has transacted the business of the association. The list of applicants for membership was then read, and after their election the meeting adjourned.

The afternoon session commenced at 2.45 p. m., and the first business was the election of officers, which resulted as follows: President, R. Caffery, Lehigh Valley R. R.; First Vice-President, A. S. Weston, New York Central R. R.; Second Vice-President, T. Hickey, Michigan Central R. R.; Secretary and Treasurer, J. B. Dickson, Chicago & Northwestern Ry.; Member of Executive Committee (for a term of three years), Wm. Brandt, New York, New Haven & Hartford R. R.

The general business having been disposed of, the reports of committees were taken up, the first on the list being that on "Tie-Plates," an abstract of which is given in another column.

The discussion on this important subject was far from satisfactory, being mainly of a desultory and fragmentary character, in spite of the fact that nearly every man in the room had more or less experience with tie-plates, and in spite of the vigorous remarks of Mr. Jones and Mr. Kerwin, who rightly rebuked the members for this unreadiness. They meet mainly for the purpose of discussing practical questions, and if they do not discuss them a great proportion of the value of the convention is lost. As Mr. Jones said, if he were to talk to any one of these men when meeting him out on the track, they would give their own ideas and experience freely, and probably criticise the report in some way, while here they practically allowed it to pass by with only half-hearted consideration.

Mr. Collins said that in his experience tie-plates do hold the rails to gage, and he much preferred a plate with a shoulder the full width of the plate, as it puts a greater proportion of the resistance on the inner spike. He has had plates on 3° curves in main track, and 10° curves in branch track, laid five years ago, the rail braces being at the same time removed, and there has been no occasion to re-gage the track. It would be a wise economy to use tie-plates on all curves, and especially on switch leads, as ties and switch timbers wear by rail cutting and the adzing of the seat of the rail to set it back vertical. The use of a shoulder greatly reduces the wear or "necking" of the spike. A shoulder plate is preferable in any case, but he would insist upon it for use on curves. He was also strongly in favor of the use of tie-plates instead of rail braces. Mr. Hawkins (Nor. & So.) said his road uses cypress and white cedar ties, and next year it will complete the application of tie-plates to all ties. A great advantage in their use is the avoidance of continual re-gaging of the track. He was not inclined to believe in the necessity of using a shoulder on the plate, especially if the plate is properly punched to fit the spikes and rail. Mr. Dodson said that with oak ties it was not economy to use tie-plates on curves of less than 3°. He put plates on a 10° curve 18 months ago, and has had no trouble, while formerly using a brace on each tie, the track had to be re-gaged twice a month. Mr. Ross (Flint & P. M.) said that the use of the tie-plates increased the life of hemlock ties two years. He thought tie-plates better than rail braces, while the latter require three extra spikes to each brace, and the former requires no extra spikes.

Mr. Shanks (C. Vt.) said that in Massachusetts the life of a hemlock tie is about five years without plates and eight years with plates, but he would prefer a wider base to the rail instead of using tie-plates, since in his opinion this would give the same advantage at less cost.* He has used plates with and without a shoulder on top, and prefers the former. Mr. Greening (Lehigh Valley) said that in one case the rail necked the spikes so much as to widen the gage and nearly cut off the heads of the spikes. Mr. Dodson (So. Ry.) said that a shoulder added about 2 cts. to the cost of a plate, but he questioned the use of a shoulder, more particularly one 5 ins. long, or a shoulder on each side of the rail. With a rail brace, the cutting of the tie along the edge of the rail base throws the weight upon the head of the brace, tending to pull the spikes at the heel, while the tie-plate prevents this first cutting action. Other members spoke in favor of a shoulder tie-plate, with shoulder the full length of the plate, and Mr. Stickney (B. & Me.) said that he shimmed on top of such a plate. A vote was taken on the question of the advisability of using a shoulder or lip on the upper surface of the plate, and resulted as follows: 39 in favor of shoulder, 7 in favor of a flat plate. Several members, however, who use only the latter plates refrained from voting, and it should in fairness be pointed out that the flat-topped plate is the form used very much more extensively than the shoulder plates. On roads where track heaves, also, the shoulder might be somewhat of a trouble in shimming the track.

The meeting then adjourned. In the evening there was a very pleasant "parlor entertainment" at the hotel, consisting of songs, music and recitations, which was somewhat of a novelty and was very conducive to the more intimate acquaintanceship of the members and their friends.

At the morning session on Sept. 9, the first business was the election of Mr. J. A. Lahey (C. & N. P) as a member of the executive committee to fill the uncompleted term of Mr. G. W. Bishop, who has resigned on account of retiring from railway service. The report of the committee on "The Best Method of Protecting Facing Point Switches" was then read by the chairman, Mr. W. D. Otis (N. Y. Central):

Protecting Facing Point Switches.

The means of protection should be as follows: (1) A distant signal placed at least 2,000 ft. from the switch, depending upon the location; (2) A home signal located at the switch (with a positive indication in each direction to show whether the switch is set for the main or side track); (3) A facing lock which locks the switch. These should all be operated by a two-lever interlocking switch-stand, so constructed that when the signals are put at danger it unlocks the switch so that it can be operated. The interlocking system should be so arranged that the danger signal cannot be put to indicate safety until the switch is again set for the main track.

The regular proceedings were then interrupted to hear brief addresses from Mr. John Doyle (Det., L. & N.), Past President, and Mr. I. Burnett, the founder of the association.

When the subject of the report was taken up for discussion, there was little desire to speak, and such discussion as there was had to be dragged out by the vigorous questioning of the chairman, who seemed unable, however, to arouse any particular interest in the matter. Mr. Weston said the plan recommended was that used on the New York Central R. R., for single track lines; 2,000 ft. is the least distance that it is safe to give an engineman to stop his train during foggy weather, and the signal cannot show "clear" unless the switch rail is fully home against the stock rail. The home signal at the switch is not a semaphore, but a double-lever switchstand with lamp and single target; it shows a red target and light when set for the siding, and no target and a white light when set for the main track. This is the practice on this road. Mr. Coates (N. Y., N. H. & H. R. R.) pointed out that this was in conflict with ordinary interlocking rules, by omitting the one signal, so that when set for main track there is a distant signal but no home signal. Mr. Doyle suggested putting on a white target or taking off the white light, so as to make the day and night signals the same. Mr. Shanks said that as a matter of fact different roads have distinct methods of practice, and it should be the duty of the association to endeavor to crystallize these into one uniform practice. There should be at every switch a red and a white signal. The absence of the latter tends to lead the engineman into carelessness in looking out for a red signal, while with a signal for either position his attention is attracted to the switch. As a result of the opinions expressed in this direction it was voted to amend the second recommendation in the report by the addition of the phrase given in parentheses. Mr. Coates said that there were other devices besides switch locks to effect the same purpose, including a yoke which must be thrown (first setting the distant signal) before the switch lever can be thrown. Mr. Reisler thought the report ought to be extended to include switches at block signals; on the Erie R. R. the switches and block signals are operated together without the use of an interlocking machine. Mr. Caffery, however, thought that the report was intended to refer only to switches operated directly by hand and not those at interlocking points. Mr. Reisler's motion was not carried.

Next in order came a paper on "Ditching," by Mr. J. M. Meade, Res. Engr., A. H. S. F. Ry. This was read by the secretary and received as information. The following is an abstract of this paper.

Ditching.

Whilst there is a general desire for action and information on this subject among all of us, it must be admitted that we have yet a great deal to learn, and this very ignorance is mainly due to a lack of teaching and training from those who know the real meaning or philosophy of the art.

As nearly every road has its own standards in regard to cross section and shape of road bed and ditching, it hardly seems necessary to attach to this paper plans showing how track should be ditched. It is an old subject. The main object is to remind the roadmasters of the great importance attached to this matter; economy in track maintenance begins right here, and one of the most important factors in prolonging the life of cross ties and saving the rails rests with good drainage. Good ditching shows for itself and tells its own story.

Our managers should never grumble or hesitate as to the security derived and money saved in allowing the roadmaster sufficient force to keep his track well drained. One or two days' rain will often spoil weeks and months of hard work by the section foreman by neglect of this kind.

In ballasting or other important track work, great attention should be given to the matter of drainage; every ditch should be amply large to carry off all the water that will ever come into it and sufficiently deep to keep the moisture away from the ties and ballast. Frequently on new roads, cuts will slide in and sometimes make the track impassable; this is often prevented by a good surface ditch on top, placed some distance back from the top edge of the cut, as circumstances will admit. In cases where this will not stop the sliding, the writer has known bad cases cured by cutting vertical trenches on the slope of the cuts from top to bottom, placed about 20 ft. apart, as the case demands, with the dirt mounded up in oval shape between the trenches. This is a good remedy where the earth seems to be alive and constantly on the move.

Many roadmasters seem to think that it is not necessary to spend any money draining banks. This is a mistake; banks should be properly drained as well as cuts. Rough track is often found on embankments caused by the ties being buried in mud. This is wrong; ties on embankments should have free drainage from their ends, on a slope of at least over 1 in. in 12 ins. We often meet with material in cuts of a spongy or boggy nature, where even rock ballast will not keep the track smooth. I have seen bad cases of this kind cured by putting porous tiling in the side ditches and cinder ballast at least 12 ins. deep under the ties. Where places of this kind are encountered in cuts there is no end to the trouble and if the grade of the railway can be changed to at least 0.5% it will often give permanent relief.

We often hear the question raised: "How much of the time of a section gang should be given to ditching?" This can best be answered by the circumstances governing the case. In the proper seasons for this kind of work, and where sufficient help is allowed, it is considered good practice to give at least one-fourth of the time to the matter of ditching.

The next report was that of the committee on superelevation on curves and the use of easement curves; this was amended somewhat during the discussion and the following is the report substantially as adopted:

Superelevation on Curves for Speeds of 10 to 70 Miles Per Hour, and the Advisability of Using Easement Curves.

We are of the opinion that curves should be elevated for the highest speed at which passenger trains usually run over them, limited, however, to an elevation of about 7 ins. if the track also carries freight traffic. If exclusively passenger traffic we would not be limited to 7 ins. if the circumstances seemed to require more.

We recognize the various conditions that may require a modification of this rule. In such cases each will be governed by the prevailing circumstances, bearing in mind that the passenger traffic deserves more consideration than freight.

At the proper speed for which the curve is elevated each rail carries equal weight; in other words, a weighted line through the center of gravity of the car will remain perpendicular to the plane of the rails while passing the curve.

When trains pass curves at greater speeds than the track is elevated for, the weight on the outer rail is increased, flange friction is increased and the tendency to turn the outer rail over is much greater, but we believe in full elevation because it is not only safer but a much better riding track and the advance in the condition of track and increased average speed require greater attention to this matter.

We are decidedly in favor of easements for all curves of 2° or over. They make the entrance to curves gradual, reduce the shock at high speed and keep the line much better. They should be put in with a transit and should be of sufficient length to carry all the elevation at the rate of about 50 ft. per in. That is, the elevation should begin with the easement and reach full elevation at beginning of regular curve. The spiral or cubic parabola is equally good.

Where no easement curves are used we recommend full elevation at ends of curves, running it out on tangents

*It is hardly necessary to point out that this is an entirely erroneous idea. Such a distribution of metal in a rail would be very bad, and the added metal would add but little strength to the rail, while that part lying between the ties would be so much wasted metal. It is far better practice to slightly reduce the width of the rail base with a view to the use of tie-plates, as in the Dudley type of rail sections, where the width is slightly less than the height.

at the rate of 50 ft. per in., except for reverse curves. Uniform elevation, good line, gage and surface are as essential as the proper elevation for a perfect track.

Where easement curves are not put in by the engineer, good results can be obtained by throwing in the whole curve a given distance and flattening the ends by extending the curve beyond the ends of the original curve equal to one-half the length of easement. To get easement of a certain length as the curvature increases, the amount the original curves move in will increase.

Your committee recommends the use of the formula in mechanic's text books, viz.:

$$\text{Elevation} = \frac{G \times V^2}{32.2 \times R} \text{ in which}$$

G = gage of track in feet,
V = velocity of train, in feet per second, and
R = radius of curve in feet.

The following table computed by this formula shows the elevation in inches for each curve, 1 to 10°, and for speeds of 10 to 70 miles per hour, inclusive:

Deg. of curve.	Miles per hour— 10.	20.	30.	40.	50.	60.	70.	Remarks.
1	1-16	¼	⅝	1	1⅝	2⅜	3	Maximum elevation about 7 ins. by the formula given.
2	⅛	½	1¼	2	2⅞	3⅝	5	
3	3-16	¾	1⅞	3	4⅜	5½	7	
4	¼	1	2½	4	5½	7	..	
5	5-16	1¼	3⅛	5	6⅞	...	..	
6	⅜	1½	3¾	6	8¼	...	..	
7	7-16	1¾	4⅜	7	...	...	..	
8	½	2	5	8	...	...	..	
9	9-16	2¼	5⅝	9	...	...	..	
10	⅝	2½	6¼	10	...	...	..	

Mr. Doyle explained that it was not thought necessary to work out the elevation for the high speeds on the sharp curves, since in operation the trains would be slowed down on such curves. Mr. Coates (N. Y., N. H. & H. R. R.) said he preferred a formula giving a higher rate of elevation on a high degree curve than on one of low degree. Thus for curves of 1°, 2°, 3° and 4°, he would give (for 40 miles per hour) an elevation of 1½, 2⅝, 3½ and 4 ins., instead of the 1, 2, 3, 4 ins. given by the committee. He would also limit the elevation to 6½ ins. The Pennsylvania R. R. uses a cord 75 ft. long, stretched on the gage side of the outer rail, the middle ordinate being equal to the elevation. Taking a case where passenger trains run down grade at 60 miles per hour, and freight trains go up the grade at 15 miles per hour, should the elevation be calculated for the fast or the slow train, as the high elevation necessary for the former will seriously affect the operation of the latter. Mr. Stimson (G. R. & I.) said that under such conditions on his road the curves are put up for the fast trains, though the freight trains wear the inside rails pretty badly, but the management requires this to be done for the safety of the fast trains. Most of those participating in the discussion approved of the use of easement curves, though some members did not appear to be clear as to the purpose or laying out of such curves. Mr. Emery thought there are places where such curves cannot be put in on existing roads, as, for instance, where the curve ends at a bridge or tunnel, or in a narrow cut with masonry retaining walls, or where curves come very close together, while the method of flattening the ends and sharpening the centers of curves would necessitate an entire realinement and the purchase of additional right of way in some cases.

In the afternoon there was an excursion on the Niagara Falls, River & Park Electric Ry. (on the Canadian side of the river). At the evening session the report of the committee on "The Latest Improvements in Frogs and Switches" was taken up, but it did not in any way follow the ground indicated by the title, since it was merely a general sort of report on frogs and switches, reiterating recommendations which are now pretty familiar. An abstract of this report is given below:

Frogs and Switches

It is very essential that all roads should adopt some form of frog and switch as a standard, for use at all places except where some special design of construction is necessary. Where railways do not manufacture their own frogs, switches and crossings, it is well to furnish frog makers with a complete set of their standard blue prints and specifications for same, but in the event of special frogs, etc., careful measurements should be taken and blue prints furnished accordingly.

For main line work, spring rail frogs not less than 15 ft. long; and in yard work, wherever practicable, spring rail frogs of not over 12 ft. in length. Variations from this, of course, depend greatly upon the circumstances under which the work is to be laid out. Where a rigid frog is adopted for such work with a heavy traffic, a bolted and filled frog with ¾-in. steel plates is certainly preferable and more economical. A great deal depends, however, as to the kind of frog to be used, which can only be determined upon under the existing circumstances.

The clamp frog may be utilized to advantage in main line service where traffic is light; the great objection, however, to this class of frog is its inability to support itself; the clamps naturally become loose, in consequence of which the wing rails receive the weight of passing traffic, the point dropping below the surface of the wing rails, causing them, sooner or later, to become battered and useless. The only advantage gained in the use of the clamp frog is that when one wing rail is worn it admits of the frog being transposed, or having a new wing rail substituted at a small cost, thus prolonging the life of the frog. In complicated yards where a large number of switches and frogs are necessary this style of frog cannot be used to good advantage on account of the long ties, as the clamps project below the base of the frog, requiring a greater spacing of the ties or shorter ones used; whereas a frog with a plate can be used under any conditions. In yard work where sharp curves are necessary, a frog 12 ft. long is recommended, owing to the fact that frogs placed in curves of low radius require a wider throat and flangeway, consequently the space from outside of guard rail to point is greater in order to allow the wheel flange to pass through without binding, overcoming the battering and pounding down of the entire frog. The clamp frog, for the time being, gives but little trouble, having no bolts and rivets to become loose, but is on the whole a very expensive frog as a result of its loose method of construction, there being no support whatever to the point. On the other hand, the bolted frog with ¾-in. steel plates, made in proportion to the size of the frog, has a tendency to support it equally through its entire area of bearing and is certainly the most economical.

While spring rail frogs in yard construction may or may not be as economical as the bolted and filled frog, it is not good policy to make a general use of them in freight yards where a great amount of switching is required, as switchmen are more or less liable to have their feet caught in the frog. The objection to the double rigid frog, as usually made, is that the wheels are furnished with no guard in passing from one point to the other. In order to overcome this difficulty it is well to have the guard rail of the frog so made that it will shade both points ⅛-in.; in this manner one frog will answer as a guard for the opposite frog while trains are passing through the combination. Rigid double frogs up to No. 7 can be used on combinations of 8° 10'. In combination switches above this the use of movable point frogs is recommended.

In a proposed guard rail two clamps are made use of on either end which hold the rail rigid and overcome the possibility of the rail turning over. The two bends in either end have a tendency to crowd the wheels gradually through the frog, preventing them from striking the point, reducing to a minimum that sudden shock which would otherwise be the result in the use of an ordinary guard rail. For main line passing tracks a No. 11 spring frog is recommended. For yards and miscellaneous sidings it is impracticable to adopt a standard frog as all depends upon the location and amount of room at disposal.

Since the adoption of the interlocking system at railway crossings, allowing trains to pass at full speed, the expense is consequently materially increased, as they require a greater amount of care and attention. Thorough inspection should be made each day of such high speed crossings, and any defects at once remedied. Roadmasters must endeavor to keep them in such shape as to avoid the complaints which might otherwise arise from other roads with which their line intersects, reducing the cost of maintenance to a minimum, and in order to do this they should receive constant care from the time they are placed in position. A crossing should be placed in such a manner as to be perfectly rigid, and the least expense will be incurred in the maintenance of such a crossing. In order to accomplish this it is advisable, if the circumstances will admit, to have at least 4 ft. of broken stone foundation, with framed timbers of suitable kind and size, and a properly-constructed drain from the bottom of the pit. The gage of crossings on tangent should be 4 ft. 8½ ins., with 1¾-in. flangeways, placed on ¾-in. steel plates, made in proportion to the angle and area of the crossing.

On one complicated crossing the flangeway on the inside of the curve is 2¼ ins., and on the outside 2⅝ ins. The flangeway is necessarily made narrow on the inside so as to answer for a guard rail and wider on the outside to allow the necessary space for curvature of the wheels.

Switches in main tracks should be put in with a theoretical lead corresponding with the theoretical switch point, in accordance with the angle of the frog, and where a 15-ft. switch point is used, as is very often the case, the length of the lead should be shortened the difference between the theoretical switch point and the 15-ft. point, which will make the lead practicable. Where a 15-ft. switch point is used as a standard for yard work the leads can be shortened; for instance, a No. 15 frog can be used on any lead from 115 to 132 ft. No. 10 frogs are often used as a standard in connection with a No. 9 lead. Then why not use a No. 9 frog with a lead to correspond, as it certainly would be practicable, furnishing as it does a perfect curve in making use of a frog one size less and would last longer than a No. 10 if a rigid frog?

All switches should have a 5-in. throw, as they are more economical to keep in repair and also do away with that element of danger caused by wheels catching the open point, which is often the experience with switches having less throw. It is very essential to have a suitable guard rail placed 4 ft. 6⅝ ins. from the point of the frog, regardless of the gage of the track, as oftentimes tracks leading to factories, etc., are gaged to 4 ft. 9½ ins. Two tie rods on all yard switches are also recommended, with a stop block on the stop rail; the stock rail should be bent 9 ins. ahead of the point and the switch point will set up snug and in perfect shape as far back as the point is planed. A kink in the stock rail ahead of the point all the way from 15 to 20 ins., is often made use of. The objection, however, to this method of construction is that it permits worn or double flanged wheels to run in the space between the point and the stock rail as the only part of the point that sets up against the stock rail is just near the point of the switch. All main track switches should be made with reinforcement bars connected to the points, in order to hold them securely in position should they become broken, and thereby prevent in many instances a serious derailment.

At the morning meeting on Sept. 10, the first subject taken up was Rail Joints. The committee had made no report, but the chairman thought the matter important enough to be discussed even though the committee had neglected its duty.

Rail Joints.

Mr. Brown approved a suspended joint with ties 12 to 15 ins. c. to c., but with the addition of a base support; he has tried the Long and Thompson joint. Mr. Stickney has been using the Weber and Continuous joints, and his foremen claim that the latter is the easier to maintain. Mr. Black (Manhattan Elevated) said that seven years ago his road adopted the Samson angle bar on a 70-lb. rail, but after about two years' service this would break in the web. They then tried a truss joint, and then the Weber joint, which is now the standard and is applied to 90-lb. rails. Some of the Weber joints were put on old rails which had been in use nine years and were ready to be taken out. The rails improved so much at the ends that they remained in four years more. Mr. Coates said that the Weber joint is used on the four-tracks of the New York, New Haven & Hartford R. R., leading out of New York; careful measurements of the four joints which had the Weber joint applied on April 25, 1893, showed the following deflections:

	April 24, 1893. in.	May 1, 1893. in.	May 9, 1893. in.	April 14, 1896. in.
Joint No. 1	5-64	2-64	1-64	0
" No. 2	5-64	2-64	2-64	0
" No. 3	6-64	3-64	2-64	0
" No. 4	4-64	2-64	1-64	1-64

Mr. Hickey (Mich. Cent.) said that many of the 44-in. iron splice bars were taken out, straightened and put back, but the 44-in. steel bars did not give any trouble by bending. Mr. Shanks has had good results with Weber joints on new 75-lb. rails, and by putting the Continuous joints on old 60-lb. rails which had had 16 years' service, he brought the rail ends back into tolerably good surface; he approved of a suspended joint with bridge or base support. Mr. Ware (B. R. & P.) had put Weber joints on rails that had got badly pounded by 13 years' service, and brought the rails back to better condition. Mr. Sullivan (Boston & Albany) applied 12 Continuous joints six years ago; two of these were recently taken off, but a straight edge placed on the rails and on the splice bars showed no deflection. Mr. Caffery (L. V.) evaded the usual inquiry about miter joints by saying that the discussion referred to joint devices, while the miter-cut rail ends could be spliced by any form of joint device.

The next and last report was that of the Committee on Ballast, which was substantially as follows:

Ballast.

1. What is the best kind of ballast?

Stone.—Ballast made from stone, crushed to the proper size for tamping, that will neither solidify in track, nor disintegrate while being worked, makes the best ballast.

Gravel.—The term gravel, as ordinarily used, applies to so many different kinds of material that, in alluding to it, an explanation should follow each statement describing the quality of the gravel in question. We have seen gravel in small quantities, generally in pockets, that was clean, hard stone; ranging in sizes from that of a pea to a hulled walnut. No material could be better for ballast than this, but, owing to the amount of soil and fine sand that is usually put in track with the gravel, we find it inferior to crushed stone.*

Burned Clay.—This has many qualities to recommend it for ballast, and those who have used it the longest are the most enthusiastic in its praise.

Furnace Slag.—This makes very good ballast, and the same may be said of locomotive cinders under certain conditions.

2. What are the best methods for handling different kinds of ballast?

The methods of handling ballast differ under different conditions and localities. What would be economical in one case, would be expensive in another.

Stone is generally moved from the quarry to the crusher by small dump cars on an inclined railway, attached to cables. Where it is convenient to locate the crusher about level with the quarry, parties who move the stone with dump carts claim that they can do it more economically than with cars. After the stone is crushed, it is elevated and put into storage bins, convenient to load into cars by gravity. The distribution of crushed stone on track can best be done with hopper bottom cars. The Rodger ballast car is, perhaps, the most complete car for this work that is in general use.

Gravel can generally be more economically loaded with steam shovel than in any other manner. It can best be handled in hopper bottom cars also, or may be distributed with good success on flat cars, when the haul is not too long, and unloaded with the rapid unloader. Furnace slag and locomotive cinders may be handled the same as gravel.

3. What is the best kind of cross-section for each kind of ballast, both as to roadbed and ballast?

The best cross-section is the one which will keep the destructive elements farthest from the track. Roadbeds should be wide enough to reduce the heaving of the track to a minimum.

They should be drained below the frost line in all clay cuts. Where it cannot be done by open ditches, it may be successfully done with tiling. Whether drainage is made in open ditches or under ground, it should be done with the view of getting the water away from the track as quickly as possible.

In the discussion on this report, Mr. Caffery said he thought ¾-in. stone too small, and would prefer it 1½ to 2 ins. in size, as with this limit there would be plenty of the smaller sizes to fill in. Mr. Coates had tried 2½-in. stone, but found it too large, the stones from the crusher coming out in long narrow pieces, so that a stone of 2½-in. section is entirely too large; he favored breaking to a 1½-in. ring, and thought ⅝-in. so small that in tamping the stones would be crushed and broken. He has used trap, limestone and sandstone, the latter being very unsatisfactory, as might be expected, as it breaks in tamping and gradually crushes. Mr. Mott laid one mile of ⅝-in. stone screened from dust and dirt, which made excellent ballast, but he would prefer 1½-in. stone similarly cleaned. Mr. Lahey considered it the best practice to use a bottom layer of coarse stone and a top layer of screenings. Mr. Brown thought there were as many varieties of stone as of gravel ballast. If stone is crushed fine it disintegrates so rapidly that it is expensive, and he therefore uses a 3-in. ring. With light rails on coarse stone ballast, however, it is difficult to keep the rail in good surface, as the stones cut into the tie and make an uneven bearing. Mr. C. E. Jones (C., B. & Q.) said that in 1890 his road accepted the proposition of Mr. Davey, of Chicago, to burn 10,000 cu. yds. of clay for ballast, and now the road has hundreds of miles so ballasted, 58 miles being on his own division. Gumbo (not clay) makes the best material for burning as it has more combustible matter than clay, and comes

*Reference might have been made here to the practice of washing gravel for ballast.—Ed.

out in pieces about the size of a walnut, though some clay makes good ballast. Even good stone ballast will crush under bad rails, and burned clay has been criticised because it has failed under similar conditions, but if properly burned and properly laid under good rails it is an excellent material. On newly ballasted track, the burned clay is laid about 8 ins. deep under the ties. At first it cost about 90 cts. per cu. yd. at the pits, but now it costs only about 19½ cts., the company furnishing the ground, coal and tracks. One ton of coal will burn about 5 cu. yds. of ballast. Slack coal is used with a little hard coal to help the fires, but wood will not answer the purpose. There must be an experienced man in charge to attend to the burning. Contrary to the claims of contractors welds will grow in this ballast. As to the handling of ballast, several members spoke in favor of the Rodgers' ballast car.

A motion to reopen the discussion on tie-plates was suggested by Mr. Emery, but it was eventually decided to take up the subject again at the next annual meeting. After the passing of various resolutions of thanks, etc., the meeting adjourned. In the afternoon there was an excursion to the power house of the Niagara Falls Power Co., and a dinner was given at the hotel in the evening. On Sept. 11 there was an excursion by rail to Lewiston, and thence by boat to Toronto, and a very large number of members participated in this trip. The next meeting will be held at Old Point Comfort, Va., on the second Tuesday of September, 1897.

There was a large and representative exhibit of track materials and appliances, arranged by the Road and Track Supply Association, of which Mr. H. W. Frost is Secretary, and a general statement of these exhibits will be found in our Supplement this week.

CONVENTION OF THE STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK.

The fourteenth annual meeting of the Street Railway Association of the State of New York was held at the Bennett House, Binghamton, N. Y., on Sept. 8, with President G. Tracy Rogers in the chair, and 33 delegates of street railway companies and about 60 other attendants present. President Rogers delivered an interesting address.

The executive committee made its report, laying special stress upon the importance of carefully watching bills presented to the State Legislature affecting the physical and financial operation of street railways. In the last session 140 bills and amendments of this character were presented. In view of the increased attendance and volume of business to be transacted the committee recommends that hereafter two days shall be devoted to this annual convention. The report of the Treasurer showed, for the year, receipts of $6,997.86, and an expenditure of $6,700.88. The reading of reports was then taken up and Mr. G. H. Stedman, of Rochester, N. Y., presented the first, upon "The Matter of Transfers." He believed that a liberal transfer system, properly guarded to prevent fraud, pays; and, within certain limits, the more frequent the transfer points, the better. The weight of opinion now seems to favor the "ringing up" of transfers as well as cash or pass coupons. In the debate which followed Mr. Rossiter, of Brooklyn, said that in August his company transported 2,000,000 passengers on free transfers, and increased earnings $40,000. He ascribed the gain to a liberal system of transfers, as his company gives a transfer to a passenger riding on a transfer; though he doubts if 2% of the passengers demand the second one. Mr. Deming, of Buffalo, complained of the abuse of transfers in his city, stating that the system there was so laid out that it is possible to ride all day long on a transfer. Some more complicated system of tickets with the names of streets printed upon them may remedy the matter, but he was not sure. Mr. Robinson said that there were lines in New York city upon which five or six transfers could be secured; the passengers give these tickets to boys who sell them, and trouble results. The travel is too great to permit the use of punched tickets. Investigation, however, shows that the illegitimate use of tickets is not great. On lines in the retail dry-goods districts transfers cause a large increase in travel. To a question of the percentage of transfers as compared with cash fares, delegates answered as follows: In Syracuse, 25% of the passengers were carried on transfers; Buffalo, about 32%; Binghamton, a little less than 25%; Rochester, 27 to 30%; Brooklyn, 22 to 25% in summer, and 16 to 20% in winter; on the Atlantic Avenue Line in Brooklyn, 16% was the average for nine months in the year.

Mr. C. Loomis Allen, of Syracuse, read a paper on "General Track Construction, and the Most Approved Method," advocating especially the use of a harder quality of steel in the rails than was generally furnished. He said that none of the high-carbon rails on the New York Central Railway, near Spuyten Duyvil, have broken after six years of unusually heavy traffic, though the makers saw fit to warn the railway company that they would not be responsible for any damage resulting from the use of what they considered unfit material. Mr. Allen quoted "a firm of steel inspectors" to the effect that high-carbon rails would give from 40 to 60% longer life than rails of ordinary Bessemer steel. To-day, these rails cost no more than ordinary steel rails. In Syracuse rails are being now laid 60 ft. long, 9 ins. high and of the half-groove section. The joint is the ribbed or corrugated 12-bolt, 36-in. joint. Mr. Rossiter said that his company used practically the same rail, but in 30-ft. lengths, and few rails break in handling and the wearing results are more satisfactory than with the old rail. The President closed the discussion by saying that he did not know of many roads adopting the high-carbon standard.

Mr. W. W. Cole, of Elmira, presented the next paper entitled, "How Can We Prevent Accidents and Increase the General Efficiency of Employees." He regarded the proper selection of employees as the first and most important requisite, and he submitted a series of questions put to all new men, the most important of which were as follows: Relating to the ownership of real estate or personal property; to personal debt; the use of intoxicants; the highest wages previously received anywhere. Mr. Cole recommended that all employees should be placed under a bond of at least $200, as this had a restraining influence upon the men and also upon business men recommending men to the company. After a man has been turned in as competent by his instructor, he should pass an examination as to his duties and the regulations of the company. All motormen should be furnished with blank reports to be filled out each evening and giving the condition of his car, and file this report with the foreman of the shops. If trouble with any part is reported, an inspection should at once be made, the report signed by the inspector and sent to the superintendent. Such a system is more efficient than mere verbal reports. Thorough shop inspection is another important preventative of accidents; and this demands a system of reports in all departments that will form a connected chain and check the work of the individual, provided that the system is not complicated and is always attended to. Loss of power is a frequent cause of accident, and no road should try, from an economical point of view, to run too close to a theoretical consumption of power. There are too many contingencies which theory will not meet. Mr. Robinson described the system of instruction in use on the Metropolitan Street Railway. His company has organized a club in one of the depots where a series of lectures are given every two or three weeks, illustrating by stereopticon views the underground trolley, cable machinery and apparatus and the general operation of the road. He considered individual instruction preferable, but stated that the lectures were largely attended and were advantageous. Mr. Rossiter's company depended entirely upon instructors to teach the men the running of the motors, and the superintendent was supposed to instruct the men in the details of each division, grade crossings, stops, etc. Out of 1,000 men employed in August only 16 motormen left the service of the company in that month, showing that the men took an interest in their work. Mr. Fitch, of the Erie Railway, and Mr. C. D. Hammond, of the Delaware & Hudson Canal Company, both approved of the thorough examination of all employees, with schools of instruction.

Mr. H. S. Newton then read a paper upon "Power from the Trolley Circuit." He advocated the sale of surplus power to manufacturers as the only way of reducing loss from idle machinery. In New York State this method of disposal is attended with many difficulties owing to the restrictions put upon it by the insurance people. He illustrated the advantages possessed by the railway companies, as producers of power for private consumption, as follows:

Take for example a station in one of our cities containing a 1,200-HP. direct-coupled Corliss engine held in reserve, and estimate what could be done with this engine and its attached generator were it thrown into active duty on a private consumer's power circuit. Figure on an investmentment of $75,000 in the engine, generator, and other apparatus relating to the two. Then assuming coal to be worth $3 a ton and the engine to have a fuel duty of 3 lbs. per HP. per hour, we have coal consumed for each day of ten hours:

18 tons, at $3	$54
Cost of labor, engineer, firemen and oiler, say	10
Oil and waste	2
Incidental repairs	10
	$76
Add to this 10% depreciation for one day	21
And interest on the investment at 5%	10
	$107

Then figuring on an ability to sell the output for ten hours in the day at 2¾ cts. per 1,000 Watt-hours, we have 1,200 HP. for ten hours equals 8,952,000 Watt-hours, at 2¾ cts., equals $246. With cost of production as above stated, the net profit amounts to $139.36, a fair sum to go towards reducing operating expenses.

Mr. Newton believed the purchase of this power would not only be profitable to the users of the smallest unit, but also to those using 50 to 100 HP. steam plants and employing their own engineers. At 2¾ cts. per 1,000 Watt-hours, the charge would be but little over $10 per day for the equivalent of 50 HP. used uninterruptedly. The presumption is that the small engine and boiler employed to move line-shafting, with the increased power necessitated by loss in friction would more than overbalance the bill sent in for electric power. The objections of the insurance companies or Board of Fire Underwriters, seem to be embraced in the one feature of ground return. They suggest that you build a fireproof house, outside the shop, for holding the motor and run the machinery inside by a belt and line-shafting. If this is not done the insurance rate is increased 2%, because the Underwriters claim that no reliable method of insulation has yet been discovered that will make the installation a good risk. Mr. Newton said that in Syracuse there were 400 or 500 iron poles, each pair of which was a dead ground to the trolley wire suspended between them. Yet in three years there has been no ground on these poles. He admits that many disastrous fires have been started by defective installation; but he contended that a large percentage of these resulted from the contact of a current-carrying wire with water or gas-pipes; and that 90% of the arc-light circuits, if subjected to the gas-pipe test, would show as great a capacity for kindling fires as the trolley circuit. Yet these arc circuits, with 3,000 to 5,000 volts difference of potential and their invariably grounded circuits come into any building. He believed that with protected wiring and reliable insulators, both systems could be made absolutely safe.

Mr. James B. Cahoon next read a paper on the "Daily Inspection and Care of Car Equipment." He advocated a rigid daily inspection of motors, trucks and car-bodies by competent inspectors, and enters into the detailed processes of this inspection. Mr. H. S. Cooper, of Schenectady, presented a paper on "The Desirability of Forming a Board of Claim Agents," the subject matter of which was referred to the executive committee.

In the afternoon session Mr. F. O. Rusling, of Rochester, introduced "The Use of Old Rails as Underground Conductors." Mr. Rusling, while Superintendent of the Buffalo Railway Company, called in expert advice to remedy serious indications of electrolysis of pipes within a half-mile of the power house. The pipe system affected and surveyed included three systems of natural gas pipes two of illuminating gas, one of water pipe and two conduits. The large copper cables already connected were found to be entirely inadequate. The danger points lay, one 1,500 ft. north and the other 1,800 ft. east of the power house, with deliveries of 1,000 and 3,000 amperes respectively. To bring this current to the power-house with only 5 volts loss, would have required the use of $8,000 worth of copper. In this emergency the expert recommended the use of some old tram-rails on hand, worn down to 50 lbs. per yard, high in carbon and brittle. Their conductivity was tested to 1,500 amperes, and finally four rails laid parallel were tried on the 1,500 ft. length. Mr. Rusling describes the connection of these rails as follows:

The rails were bolted in pairs back to back and arranged so that the end of one rail was at the center of its mate. The bonding was effected by scraping contact spots with a file near the end of each rail and amalgamating them with the Edison solid alloy. A steel washer, ¼-in. thick, 1¼ in. inside diameter and 4 ins. outside, was dipped into hot insulating compound and placed against one rail so as to enclose the contact spot. The hole in the washer was then filled with the Edison-Brown plastic alloy, inclosing an amalgamated steel spiral spring. The upper rail was then bolted on and the completed conductor lowered to the bottom of a wooden trough, resting on one edge so that gravity would maintain the contacts. It will be evident that with this arrangement, two of the bonds on any one rail would have to give way before the circuit could be broken; each bond was made sufficient to transmit 1,500 amperes. When the second set of rails was lowered into place, the trough was filled with a hot insulating compound and a cover nailed down. This compound was cheaper and better than asphaltum; it remains viscous even in cold weather and has high insulating qualities. It is a product of petroleum distillation much lighter than asphaltum and costing about $25 per ton.

This four-rail conduit carried at heavy load 1,100 amperes 1,500 ft. with a loss of 4 volts, as ascertained by repeated and careful testing. A copper insulation would have weighed 20,532 lbs. and cost $2,462.83; the rail lengths weighed 50 tons and cost as scrap but $400. The steel resistance, with 50 bonds in each length, was about 5.63 to 1. The 1,800 ft. length was then treated by laying a 14-rail conduit, with some improvements in the method of assembling them. When tested the performance was again satisfactory, as the 14 rails transmitted 3,250 amperes 1,800 ft. with but 4 volts loss. The rails used weighed 210 tons, and, at $8 per ton, cost $1,680. A copper installation would have cost $10,389 for the same work. The total cost of both rail conduits was $3,322, as compared with $12,852 for equivalent copper. Mr. Rusling does not advise the use of buried rails if copper is used for connections, as it is impossible to get the full conductivity of the rails and the copper oxides rapidly in many soils. There was no discussion on this paper.

The next paper considered was on "Railway Power Stations," presented by Mr. Thomas Henning, of Buffalo, dealing generally with the points to be observed in managing a power station. Mr. W. G. Clark, of New York, then addressed the meeting upon the general subject of "Electrical Development." The convention voted to hold the next annual meeting at Niagara Falls, on the second Tuesday in September, 1897, and to devote two days to it. The officers elected for the ensuing year were: President, G. Tracy Rogers; First Vice-President, W. Caryl Ely; Second Vice-President, John H. Beckley; Executive Committee, H. H. Vreeland, John W. McNamara, Henry M. Watson, C. L. Rossiter; Secretary and Treasurer, H. A. Robinson. The convention closed with a banquet in the evening.